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BY

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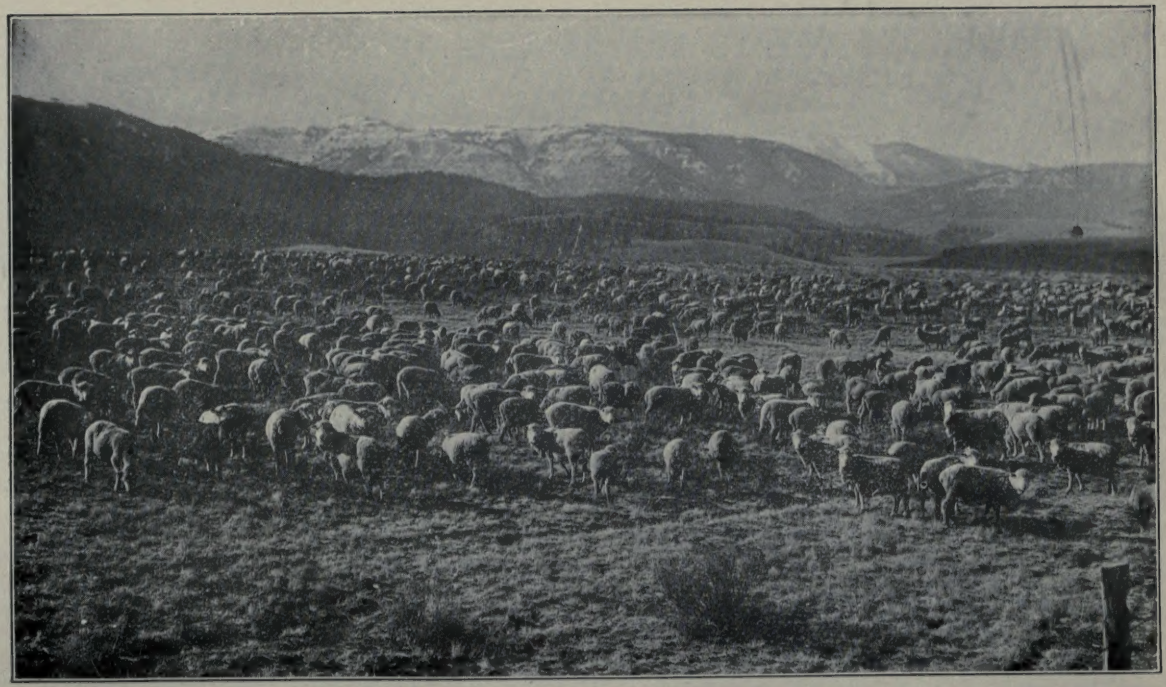


A FLOCK OF SHEEP IN ONE OF THE WESTERN STATES

STORIES OF INDUSTRY

VOL. II.

CLOTHING

THE sun is the source of heat and life. Some parts of the earth are so hot that the natives wear little clothes, but in our climate we are not safe from change of weather, from wet to dry, or from hot to cold.

Clothes are worn to keep in the heat of the body. They cannot warm us as do the fire and sun.

Coats, dresses, shirts, sheeting are all made of

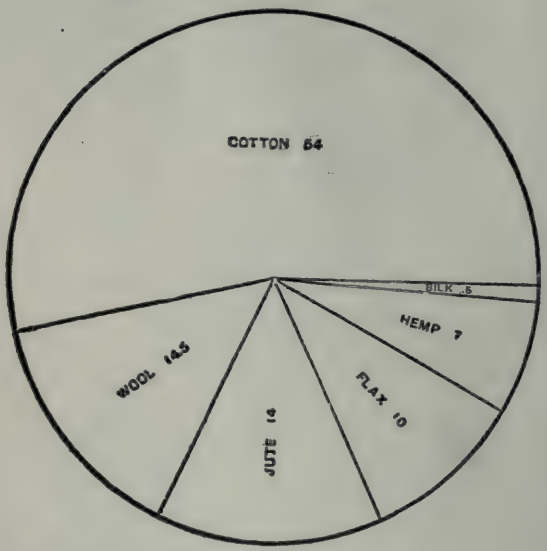
the spun and woven fibres of wool, silk, flax, cotton, jute and hemp. Wool and silk are animal fibres, flax, cotton, jute and hemp plant fibres.

Wool forms the warm fleece of the sheep, which, when winter is over, is shorn off with a pair of shears, and converted into a warm coat for man.

Silk is spun from the mouth of a caterpillar.

Flax is a small plant, with a pretty blue flower. Its seed is the well-known linseed, in such great request for so many useful purposes.

Cotton, or cotton-wool, is the soft, downy covering of the seeds in the pod of the cotton-plant.

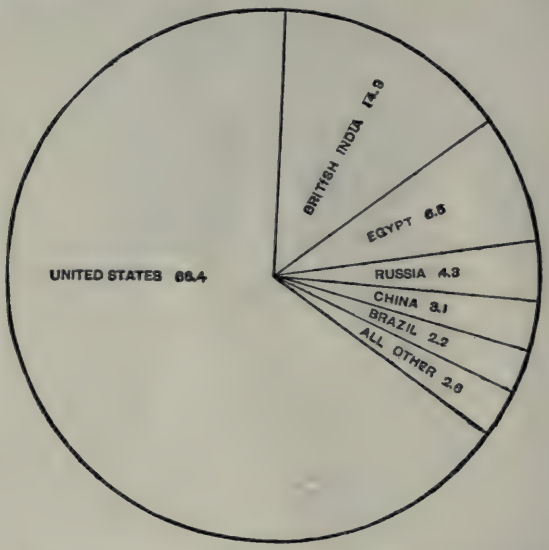


RELATIVE IMPORTANCE, IN PER CENT OF QUANTITY, OF THE SIX LEADING TEXTILE FIBERS; 1908

COTTON

COTTON is a plant that needs a warm climate and a dry soil; it is therefore found in the warm temperate and in the torrid zone of Asia, Africa, and America. This plant was discovered to be valuable for the manufacture of cloth long before the Christian Era. The Chinese are known to have manufactured cloth from cotton as early as 500 B. C., and in India there are old books in which cotton is mentioned, that were written eight hundred years before the birth of Christ. When Columbus discovered America he found cotton to be the chief material of clothing among the Indians. America proved to be so well suited to the growth of cotton that more was grown every year.

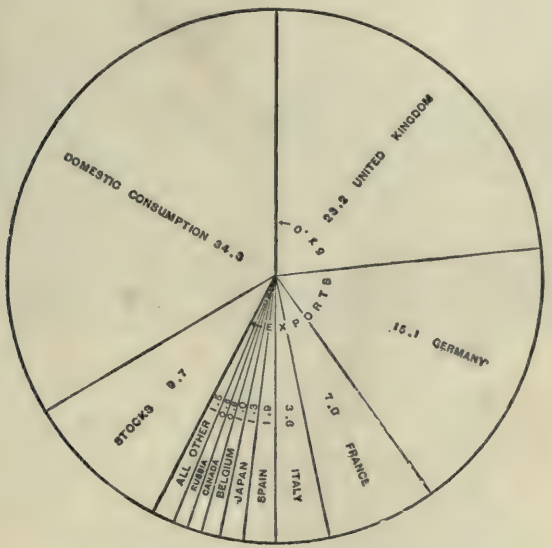
In the United States over 14,000,000 bales are raised annually. This is about three-fourths of the crop of the entire world. Of this one-third is manufactured in our own country.



PROPORTION OF WORLD'S MILL SUPPLY OF COTTON CONTRIBUTED BY EACH COUNTRY (GROWTH OF 1908)

Such a crop represents, in value of fibre, seed and other by-products, in excess of a thousand millions of dollars, or double the world's production of gold in any one year since the discovery of the yellow metal. In twenty years the production in the United States has increased from 6,650,000 bales to 14,000,000 bales of 500 pounds each. Its farm value has increased from 8 to 11 cents a pound and the acreage from 27,000,000

to 35,000,000. Exports of the fibre have grown from 5,000,000 to 10,500,000 bales, and of the manufactured cloths from $30,000,000 to $52,000,000 in value.



PROPORTION OF SUPPLY OF COTTON FOR 1909 CONSUMED IN THE UNITED STATES, HELD IN STOCKS, AND EXPORTED, WITH DISTRIBUTION OF EXPORTS BY COUNTRIES TO WHICH EXPORTED

Twenty years ago cotton by-products were practically worthless. Last year exports of cotton-seed oil alone were worth $21,694,345. To-day the by-products alone would make cotton a profitable crop. The world's production has kept pace with that of this country in average increase, but the United States continues to grow somewhat more than two-thirds of the whole.

LOADING COTTON ON THE LEVEE, NEW ORLEANS

The bulk of 14,000,000 bales is simply inconceivable. Ready for market, each bale measures 28 by 56 by 18 inches. Packed as closely as possible, these would cover a surface five and a half miles square. Placed end to end, the bales would reach from Galveston, the principal port of shipment, across the cotton-growing States to Boston, thence across the Atlantic to Liverpool, the great cotton market of the world, and beyond across Europe and Asia to Calcutta, the final destination of much Texas-grown fibre. Laid four bales abreast, they would form a carpet 18 inches in thickness and $9\frac{1}{3}$ feet wide, from Boston to San Francisco. By weight, when picked, but one-third of the cotton boll goes into this mass, two-thirds being hulls, seed kernels and linters, all of which have commercial use and value.

There are many kinds of cotton plants. Those most cultivated are from two to four feet in height. The pods in which the cotton forms are the size of a small peach; when ripe, however, they burst open and become about as large as an apple. The withered pods hold the fluffy cotton-wool so firmly that it cannot readily escape and fall to the ground, but may be easily picked. The seeds are entangled in the fibres and must be gathered with them. The fibres are called staples. If they are long, the cotton is called long-staple cotton; if short, short-staple cotton.

Our best kind is a long-staple cotton that grows on a shrub. This thrives only on the seashore. Because it is especially cultivated on the islands at the mouth of the Savannah River it is called sea-island cotton. A small quantity only is produced. A large part of the cotton raised in the country is a short-staple variety, which grows on a plant that dies to the ground each year. This is called upland cotton.

The sea-island cotton is grown along the coast of Georgia, and in those parts of South Carolina and Florida which are adjacent to the Georgia coast.

The seeds, however, are so entangled in the staples that it took a man an entire day to pick them from a pound of cotton. For this reason, but little was done in the way of cotton-raising, until about a hundred years ago.

About that time Eli Whitney, a Massachusetts

UNLOADING COTTON IN NEW ORLEANS.

man, invented a machine that cleans three hundred pounds of cotton much better and more quickly than a man can clean one pound. This machine is made in such a way that small teeth, something like those of a saw, seize the staples and drag them between the rollers, so near together that the seeds cannot pass through. It is called the cotton-gin; the last part of the word is a contraction for engine.

When the cotton is ready for manufacture, it is sent to the markets in large bales weighing about five hundred pounds each. If the baling is done by the "Round Bale System," no handling of the cotton is necessary after it has been once forked into the suction-pipes that feed it into the gins. The lint is blown into one condenser, where it is formed into a bat eight inches thick, which is compressed by being rolled between two rollers. Then it is caught by the press belt, and wound tightly around a shaft. This winding continues until the bale is finished, the size of each bale being regulated by the amount of seed cotton.

AMERICAN UPLAND COTTON — *Bohemian*

Mature open and unopened bolls, flowers and leaves.
A big boll storm proof cotton, Waco, Texas. One-third natural size.

WEIGHING COTTON IN ONE OF THE PRESSES

COTTON INDUSTRY

WHAT an expanse of knowledge opens up in the one word cotton! We read of thousands of millions of pounds brought to the mills, made into cloth, and sent out again. We call it one of the staple industries of our country.

Cotton is made into thread, ropes and cloth; chiefly into cloth. Cotton ropes are not very good because they stretch and shrink too easily. Cotton batting is used for stuffing mattresses and cushions.

Formerly our great-grandmothers did their own spinning and weaving, at their own firesides, by means of a spinning-wheel and a rude kind of loom, and using generally for their cloth, the flax grown in their own gardens, or the wool produced by their sheep. At the present time in our country and in England the

cloths are made in looms that are run by machinery, but in India cotton-cloth is still often woven in hand-looms. A man frequently spends several months in weaving a single piece. Such cloth is very beautiful, and it is sometimes so fine that when on the grass and covered with dew, it cannot be seen. Some cloths made in Decca are called "woven wind" they are so delicate.

COTTON MILL, GREAT FALLS MANUFACTURING CO., SOMERSWORTH, N. H.

Here is a cotton mill. Massive, lofty and grand are the many buildings with their still loftier chimney-shafts and their myriad windows. Here are bales of raw cotton packed close to fill large store-rooms. Here are floors full of machines in motion doing their work as though they could think and reason. Here again are bales, this time of finished cloths. Take a

large, hard flake of cotton out of the bale as you would a handful of hay out of a farmer's rack. It is full of seeds, lumps, and bits of stick and dirt, and matted like an Indian's hair. A "blower," which blows with the roar of a blast-furnace, nibbles at it and it is gone. One blowing puffs out the seeds and cleans the cotton, and it comes back to you as fleecy as swansdown. Inside the blower there is a beater of steel which turns many times in a second, while a fan below revolves as fast. The beater thrashes and the fan winnows the fibres. The dust and refuse fall through chinks to the bottom, while a snowstorm, with flakes as large as the palm of the hand, of pure white puffy cotton-wool, drives onward.

The beating and blowing are gone through, over and over again, and, at every stage, render the cotton whiter and purer, till, after its sixth or seventh thrashing and fanning, it bubbles out at last a silent, beautiful, soft, downy river of *liquid* cotton-wool, which cosily snugs itself round a giant reel, in laps, like a roll of carpet.

These laps are hurried off to the cards or combs, in a great room crowded with a hundred carding engines; all are moving and all are doing the same kind of work. The main part of these engines consists of combs, made of stout leather, set with steel wire teeth, finer, shorter, and closer set than the bristles of a clothes brush; these combs are wound around drums, some as large as a garden roller, others smaller. The

VIEW OF A CARDING ROOM

teeth of these drums play into each other as they revolve opposite ways and each, in turn, takes the lap of cotton from the other. From card to card the cotton goes and is allowed no rest till, when it leaves the last combing, every fibre lies straight and even.

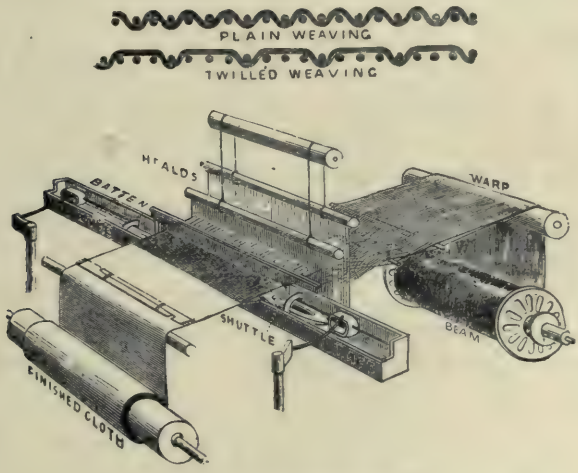
Cotton fibres, though thinner than cobwebs singly, are yet tubes. In their growth on the seed, they become twisted or spiral, a great help in carding; for just as corkscrews twine together and point all one way after a good shake, so do the filaments of cotton after carding. Fast, but gently, there is sent off at last, a thin, filmy cloud of gossamer, floating in the air, which gathers into an endless curl or sliver of pearly white cotton. Light as a wreath of smoke the sliver goes on to unite with its fellow-slivers, and with them winds at length in a flat coil upon a metal reel.

From the cards the slivers travel to the drawing machines, and now we see why so many slivers are joined in one. The filaments of cotton are not all equal, and some of them break in carding, which would make bad thread. When the slivers are doubled, over and over again, and when these doubled slivers, drawn out to the size of a candle-wick, are doubled from sixteen to twenty thousand times, the stouter threads correct the weak ones. The finer the thread, the greater the number of card-ends doubled into one. For fine lace sixty thousand or more are thus doubled and drawn out into a single delicate thread.

VIEW IN A RING SPINNING ROOM.

Now the slivers are twisted and wound upon bobbins. Now to the throstle or spinning frame.

Up to the next floor, and we are in the midst of the spinning proper. Here the spinner takes charge of generally two or more great frames called mule-frames, which move backward and forward. The spinner must "look sharp" indeed; he has no time to idle and



PRINCIPLE OF POWER-LOOM.

gossip; a thread breaks. In a twinkling, with a touch and a twist only a spinner knows, it is mended. The room is kept warm to prevent breakage.

The mule frames move forward and draw out the thread, then back they glide, and a thousand little spindles begin their whirling dance and wind evenly the thread fine and perfect at last.

Sewing-cotton and cotton thread, to the finest threads for lace, are the sole work of many great mills, where engines and frames are closely packed and busy. Others are filled with looms and warping frames, etc., for the manufacture of cloth. The contrast is wonderful between the huge factories, the fierce steam-engines, the many machines, the thousands of workers, and the little ball of cotton for which they are all brought together.

If you unravel a piece of calico you will see that the threads cross each other, twining in and out over and under, close alongside, in the length and breadth of the cloth. The art of crossing the loose and separate threads, so as to combine them into a firm, compact sheet of cloth, is called weaving. Clothes to wear have always been one of the first of our vital needs, and weavers must have been at work long before men had learned to read and write, or leave any record of their labor.

A good deal has to be done with the thread before it gets to the loom. As a rule, the twist, to form the *warp* or length-thread of the cloth, is throstle-spun, while the *weft*, or breadth-thread, which *wafts* two and fro with the shuttle, is spun upon the mule-frames. Women prepare the warp for the loom. The warping frames look not unlike giant clothes-horses, on the bars of which are placed bobbins without number. From all these bobbins the ends are culled and drawn, narrower and narrower, to a roller, just the width of

the cloth to be woven. They pass on their way through slip gauges, to keep their exact distance apart; and, round the roller they wind, a sheet of cloth without the cross thread or weft.

The action of the loom upon the warp is to raise one set of alternate threads and to lower the other set, so as to divide the warp into two sheets of thread. It is trying labor; every separate thread must be seen to, so that all shall rise and fall without a mistake, and at the same time travel on toward the shuttle.

The roll of woven cloth lengthens and lengthens as the shuttle flies to and fro, with the rap it gets on either side.

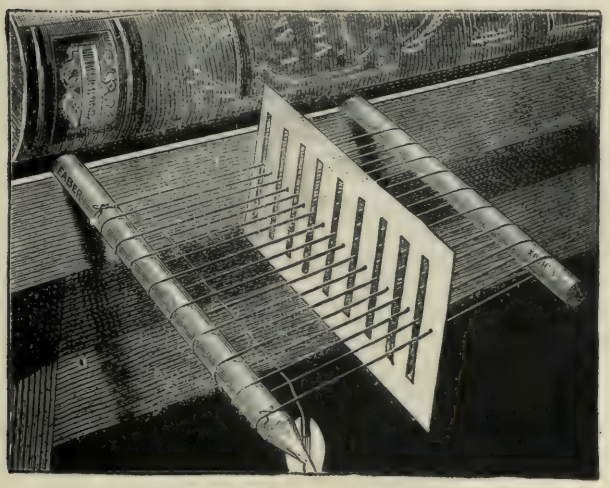
Between the two separated layers of warp threads the weaver puts in, with shuttles, the weft threads across the warp at right angles, and fills up the breadth of the web. By means of treadles both warp and weft threads are beaten up; that is, pushed up together, so as to make the cloth firm and compact.

But we want to know a little more about the principle of the loom. When these machines are in motion, we can only look on and admire the ingenious mechanism that causes them to act, but it is hard at first to understand the fundamental principle that makes them work.

If we take two lead pencils, a visiting card, a wooden paper cutter, some thread and a pen-knife, we can manufacture a loom ourselves, and see the method of working.

POWER LOOM WEAVING EARLY IN THE CENTURY.

The two pencils serve as warp beams, and we can cut a "heddle," as the frame is called which holds the threads on their way to the loom, out of the card with the pen-knife.



We can also cut one or two shuttles out of the same card, for winding the weft that is to go through the threads of the chain.

We place the pencils on the edge of the table, with a heavy book to hold them in position, as shown in the picture, and then begin warping.

This is done by attaching one end of the chain to one of the pencils, and threading a large needle with the other end, pass it through the first slit in the heddle, then wind it once around the other pencil and

through the first opening again, then around the first pencil, then pass it through the second opening in the card, and so on until the last slit is reached.

After this, in order to weave, it is only necessary to raise and lower the heddle alternately, and, as may be easily seen, the only threads carried along are

SHUTTLES AND HEDDLE MADE OF CARDBOARD

those that run through the openings. At each of these motions the shuttle must be passed between the two series of warp threads situated at different levels. A paper cutter may be used instead of a batten to push the weft home to the web.

This little device may be quickly and easily constructed, and from it the mechanism of weaving may be perfectly understood, combining amusement and instruction.

It was Tench Coxe, a prominent resident of Philadelphia, who first urged the cultivation of cotton in the South, at a time when the plant was scarcely seen outside a flower garden, and he was very active in organizing a company for its manufacture.

This was somewhere about the year 1775, and great difficulties had to be contended with in constructing proper machinery for the different processes. So it was slow work up to the end of the century.

About that time a young man named Slater arrived in this country from England, where he had been connected with the cotton industry, and had mastered the details of the best machinery then in use. He succeeded in producing a carding and spinning machine, which greatly facilitated matters, and in 1793, the firm of which young Slater had become a partner, built a small mill at Pawtucket, which still stands, and is known as the "old factory."

The year 1811 saw the birth of the great cotton industry at Fall River, Mass., when the "Old Stone Mill" at Globe Corners was opened. The centennial of this event was commemorated in June, 1911, the celebration extending through an entire week.

Just think of the wonderful variety of cotton fabrics that have their beginning in these bales of raw cotton! Very few boys, and not many girls, perhaps, are familiar with the names and appearance of these fabrics. As such knowledge may prove useful to them in the future, we give a list in the appendix.

ENGLISH CAP SPINNING

WOOL*

ONE hundred and fifty years ago, in the days of homespun, when spinning and weaving were a prominent part of each household's duties, the value and quality of cloth was a matter of common knowledge. Familiarity with the process of making fabrics brought a general acquaintance with cloth, that does not now exist.

Many persons to-day do not know the difference between worsteds and woolens — many more cannot distinguish between those of a good and those of an inferior grade. This ignorance of quality is not to

*From "From Wool to Cloth." Copyright by the American Woolen Co., to whom we are also indebted for the beautiful illustrations used with the text.

be wondered at when we consider that what was once a part of household work has become a great national industry.

To-day the American Woolen Company is the largest manufacturer of woolens and worsteds in the world. It employs 30,000 people and has a total output of all classes of fabrics of 50,000,000 yards per annum.

It is interesting to consider that the 50,000,000 yards of woolen fabrics made annually by this one American company would make a belt around the world, and would leave a length besides which would extend from Boston across the American continent, overlapping San Francisco and reaching many miles into the Pacific Ocean. From this you will readily see what countless numbers of sheep must be shorn of their fleeces to supply the wool needed for all the woolen mills, where upwards of 179,000 operatives are employed.

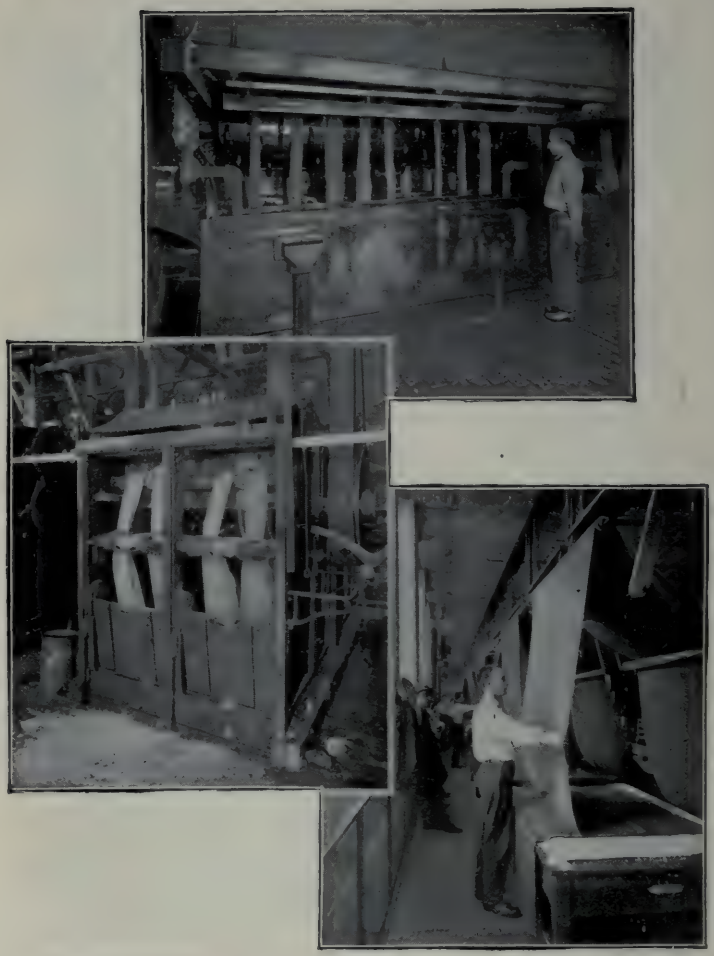
In the United States there are as many as eight hundred thousand farmers and stockmen who own sheep or are interested in the growth of wool. Although wool growers are found in every State, it is throughout the Western States, where immense flocks are grazed on the great plains, that most of the wool is produced. In Montana alone the number of sheep shorn in a single year, in round numbers, is about five million, the amount of wool obtained being about thirty-five million pounds.

SHEARING SHEEP BY MACHINERY

Once a year, in the spring, the ranchmen hold their sheep shearings. A celebration is usually held on these occasions, at which there is much merry-making and feasting. In some of the States, however, like California and Texas, the sheep are sometimes shorn twice a year, in the spring and fall. For instance, in the spring the sheep are shorn in April or May, and then again in the fall, in September or October. Sheep that are shorn twice a year, of course, produce a shorter wool than those shorn only once.

When the time comes, the sheep are gathered and penned at one end of the shearing place. As a sheep is let out, the shearer, armed with long shears, throws the animal off its feet between his legs. First he slits off the wool around its head, down the neck, and all along the side, then, turning it over, he shears the other side, keeping the fleece whole, and cutting evenly all the way. The fleeces are bound with thick ropes of wool and made ready for the market. Shearing machines are now largely used on large ranches, and rough sorting is done in the sheds.

Every kind of sheep produces three kinds of wool. *Lamb's wool*, which is taken from the lambs when they are about six months old, is the very finest and softest. *Yearling* is the wool taken from a sheep of a year old, and many woollen merchants consider this the very best crop of wool. The third class of wool is known as *ewe* or *wether fleeces*. Ewes are female,



(1) PIECE DYEING (2) FULLING CLOTH (3) FINISH PERCHING

—From "From Wool to Cloth" (Courtesy of American Woolen Co.)

and wether male sheep. The fleeces from these sheep are shorn after the first year.

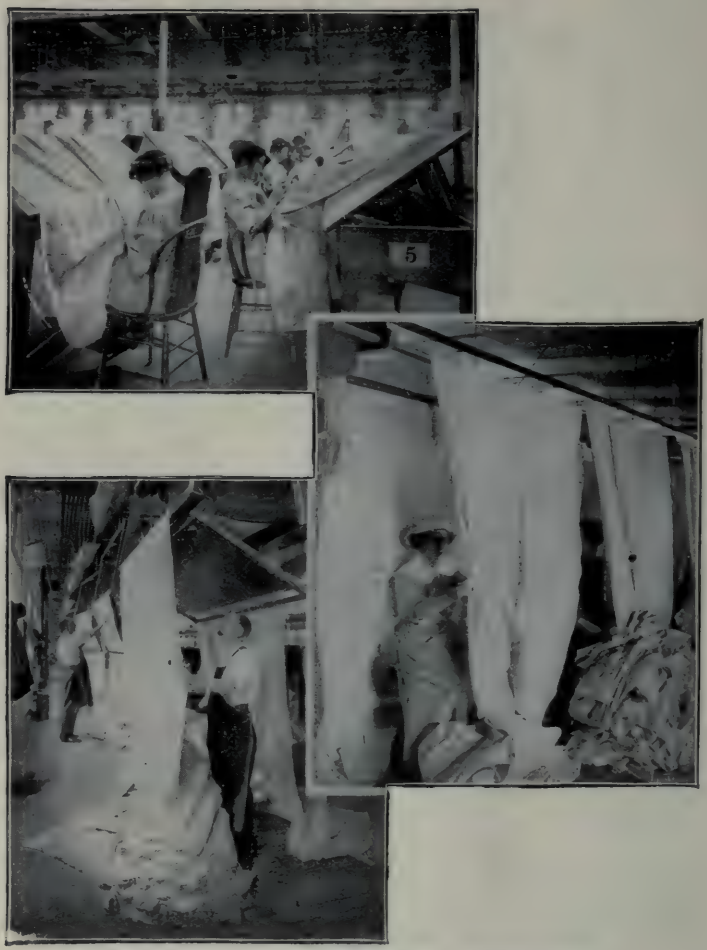
The great clothing-wool-producing countries of the world are those of Australia, South America, the United States and South Africa.

The world's wool production for 1916 was estimated at 2,717,223,100 pounds, of which the United States was supposed to have raised about 288,490,000 pounds, over one-tenth of the total.

It is estimated that about two-thirds of the clothing wool used by American manufacturers is raised in the United States.

The largest producer of the best wool, that is, of the finest fibre, is Australia. This is due to the fact that the sheep are grazed there under the most favorable conditions. There are no severe winters, and as a consequence the sheep do not have to be sheltered, and they graze in a grassy country, which makes the wool clean, light, and attractive. This is quite different from our own country, where many of the sheep have to be housed during the winter and fed from the barns. The sheep, like boys and girls, will show whether they are well fed or not, and this can be seen in the wool produced.

A well-fed, healthy sheep, grazed and housed under favorable conditions, and well taken care of, will yield a much better fleece of wool than one laboring under the reverse conditions. The severe winters that we have here in the United States are sometimes very



(1) MENDING ROOM (2) BURLING — RAISING KNOTS
(3) MENDING PERCHING

—From "From Wool to Cloth" (Courtesy of American Woolen Co.)

harmful to the sheep. But with all these adverse conditions much of the wool raised in the United States, particularly in Ohio, Pennsylvania and West Virginia, is of very fine quality — fairly rivalling that of Australia.

There is a great difference also in the qualities of different wools. The wools from different States and countries differ, the wool raised on different breeds of sheep in the same country differ, and the wool raised on any single sheep is not all the same value for manufacturing purposes.

The best wool in soundness of fibre, softness and evenness of length, comes from the shoulders and side of the sheep.

WOOL SORTING

FROM WOOL TO CLOTH

WHEN wool is received at the factory it is in fleeces, and each fleece contains different kinds of fibres — long and short, coarse and fine — and it is necessary that these should be sorted into different kinds or grades, as may be desired — perhaps six or eight different kinds, according to the particular uses to which the different qualities are to be put.

The fleece is spread out on a table, the center of which is covered with wire netting, and through this netting part of the dust and other matter from the wool falls while the sorting is going on. Sorters tear with the hands the different parts of the fleece from each other

and separate them into piles, according to their different qualities.

All unwashed wool contains a fatty or oily matter which is a secretion from the skin of the sheep. The effect of this oily matter is to prevent the fibres of the

WOOL SCOURING

wool from matting, except at the ends, where, of course, it collects dust, and, forming a sort of a coating, really serves as a protection to the rest of the fleece while on the sheep's back.

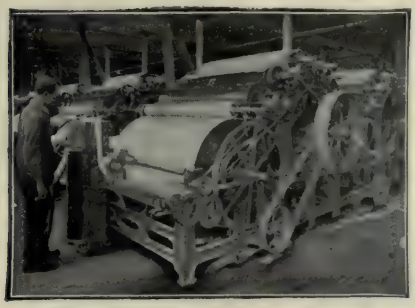
After the wool is sorted it is next cleansed or scoured, in order to remove all the grease and dirt. This is done by passing the wool through a washing machine, consisting of a set of three or four vats or

bowls, which contain a cleansing solution of warm, soapy water. The wool is next carried by a belt made of slats on chains, to a drying chamber, where is taken out most of the moisture. It is then blown through pipes or carried on trucks to the carding room.

From this point the wool follows one of two different processes of manufacture — that of making into worsteds, or that of making into woolens.

The difference between worsteds and woolens is, principally, that in the threads or yarns from which worsteds are made the fibres of the wool lie parallel, one to another, being made from combed wool, from which the short fibres have been removed; and woolens are made from yarns in which the fibres cross and are matted and intermixed. When finished the effect of worsteds and woolens is materially different. Upon examination it will be found that the worsted thread resembles a wire in evenness, while the woolen thread is uneven and irregular.

A worsted fabric when finished has a clear, bright, well defined pattern, seems close and firmly woven, and is of a pronounced dressy effect; while woolen cloths are softer, they are more elastic, the colors are more blended, the threads are not so easily distinguishable and the general effect is duller.



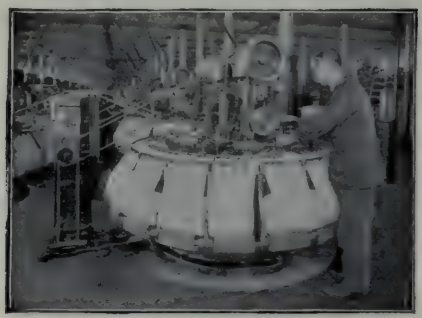
(1) WORSTED CARDING (2) GILLING AFTER CARDING

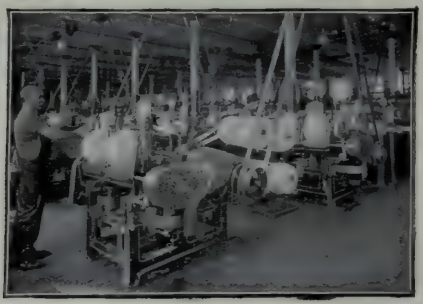
WORSTEDS

The next process in the manufacture of worsteds is carding. In this process the wool is passed between cylinders and rollers, from which project the ends of many small wires. These revolving spikes tear the wool apart, opening, separating and straightening the fibres; and then delivering the wool in soft strands, which are wound upon a wooden roll into the shape of a large ball, or put into a revolving can. The strand from a number of these balls

or cans is now taken and put through what is known as the gilling machine, which further straightens the fibres.

By means of another machine, called the comb, the fibre is still further straightened out, the short

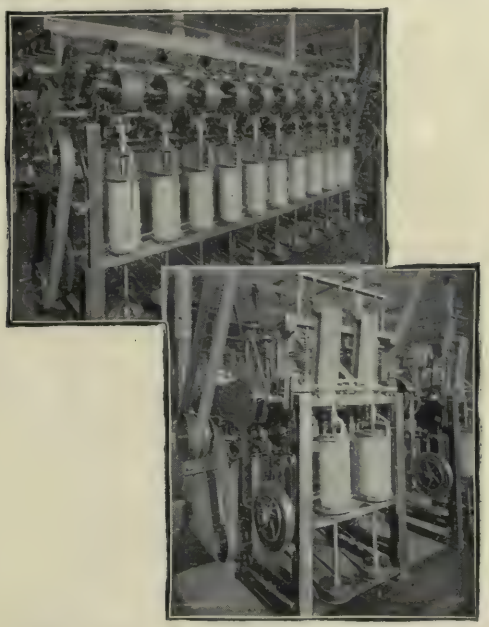




(1) COMBING (2) GILLING AND MAKING TOP AFTER COMBING

stock and nibs are removed; and when at last the finished strand comes from the combs most of the fibres are parallel to each other. A number of the strands taken from the comb are then put through two further operations of "gilling," and wound into a large ball, which is called a finished top.

The dyeing is done in three ways — in the top, in the thread or skein after being spun, or in the piece after it is woven. If the wool is to be stock dyed — that is, dyed in the top — it is sent to the



(1) GILLING — FIRST OPERATION, ENGLISH DRAWING
(2) REDUCER — ENGLISH DRAWING

dyehouse to be dyed the shade required, and afterwards returned to be gilled and re-combed ready for the drawing.

Up to this point there has been no twist given to the wool, nor any appearance of a thread. The top, the soft untwisted end, is now run through the "draw-

ing machine." This process sometimes consists of nine distinct operations, for the wool is drawn and redrawn until reduced to the size required for its special purpose; the wool is then delivered to the spinning room on spools.

In the spinning the process of drawing continues until the twisted thread is reduced to the size required, which, either singly or twisted together in two, three or four strands, is to be used for weaving.

The threads must now be prepared for the loom, in order that the actual weaving may be done. The thread is used in two ways in weaving — as warp, which is the thread which runs lengthwise of the cloth, and as filling, or woof, which runs across the cloth from side to side.

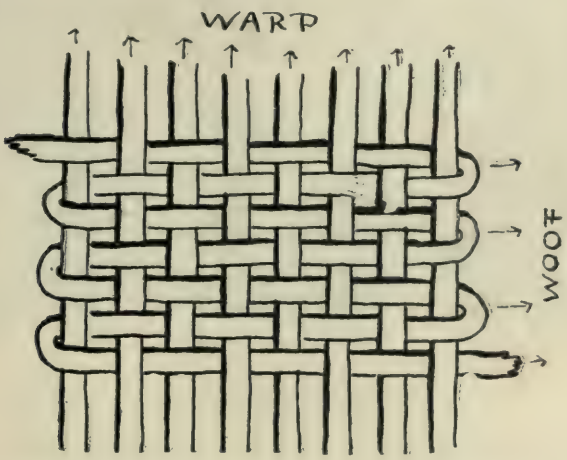
The warp threads — the threads which run lengthwise of the cloth — are sized and wound upon large reels, and from these transferred to a large wooden roll called the warp beam, which holds all the warp threads, usually several thousands.

The filling threads are put on shuttle bobbins and placed in the shuttles to be refilled by the operatives as required, and as the weaving progresses. The completed warp beam is now ready for the loom.

In the loom, by an ingenious mechanism, part of the threads are raised and part are lowered. This allows the filling shuttles to pass above some threads and below others, filling out the pattern required.

The cloth, having been made in such length as is

desired, is taken from the loom, and, by what is known as burling and mending, any knots or threads woven in wrongly are removed, and any imperfections which have been discovered through a careful examination are corrected.



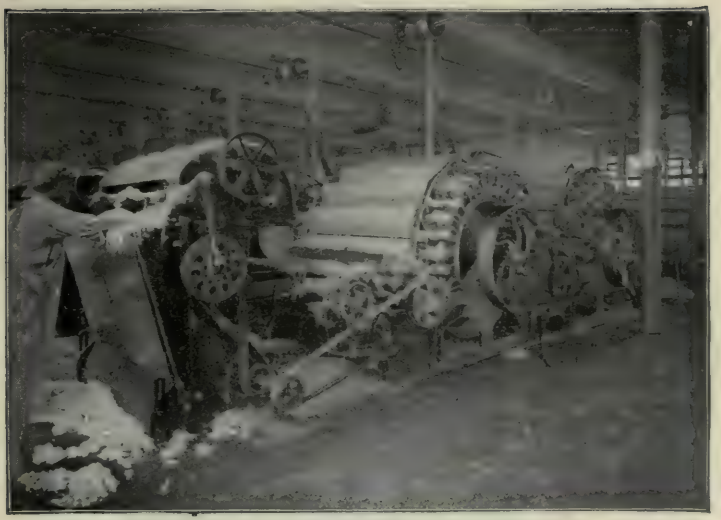
Undressed fabrics would now be "fulled." This consists of running cloth through a fulling machine where, moistened with a specially prepared soap, the cloth is subjected to a great pressure and pounding, which aids in giving the required finish.

There are different kinds of finishes which require different treatments, but it would be impracticable for us to dwell in detail upon this matter here.

If dyed in the piece, the web or cloth is taken to the dyehouse and dyed. It is then thoroughly rinsed, all moisture extracted from it, and again dried.

After drying, the cloth is run through a machine, by which it is brushed and sheared, the brushing lifting the long fibres, and the shearing cutting them off at even length. The cloth is put through a press, which irons it out, giving it the lustre or the finish that is desired. It is examined again for further imperfections, and if such have occurred they are corrected.

Measuring, weighing, rolling and tagging follow, and the cloth is packed and ready for the market.



WOOLEN CARDING

WOOLENS

Woolens are made from short staple wools, known as clothing wools, and in the finished woolens the fibres of the yarns cross or are mingled together. In the case of woolens, after the scouring, it is frequently necessary to remove burrs or other vegetable matter from the wool. To accomplish this the wool is dipped in a bath of acid solution, then the moisture is extracted and the wool is put through a "dryer," where the temperature must be at least 212 degrees. This heat carbonizes the foreign substance, but has little effect on the animal fibres of the wool.

Sometimes there is to be a blend of the wool with

other stocks, and in that case several different wools are mixed together.

Dyeing of woolens is done in three ways — in the wool, in the thread after it is spun, or in the piece

(1) FINISHER WOOLEN CARDING (2) WOOLEN MULE SPINNING

after it is woven. If the wool is to be "dyed in the wool" it is now conveyed to the dyehouse, dyed the shade required, then returned to the mixing-room.

During the process of scouring, when the grease was removed, a large part of the natural oil of the wool was also lost, and, in order to restore this, the

wool is sprinkled with an oil emulsion, which thoroughly blends the wools.

From here the wool goes to the "carding-room," and by means of the carding-machine the fibres are carded and drawn and delivered to the finisher in a broad, flat sheet. It is then divided by another machine into narrow bands, and the wool — free as yet from twist — comes out in soft strands. These strands or threads are called roping.

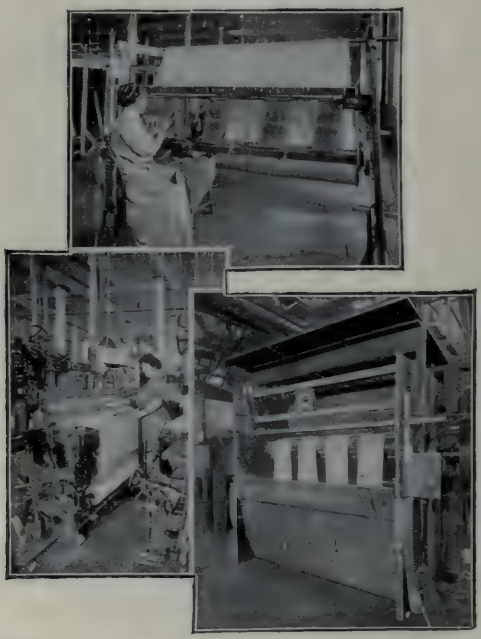
Now comes the mule spinning. The roping passes through rolls by which it is drawn and twisted to the size required, and wound on paper tubes or bobbins. Such of the yarn as is to be used for warp is wound upon large reels; from these transferred to the warp beam, as in the case of worsteds.

The processes of drawing in, preparation for weaving, burling and mending are practically the same as in the case of worsteds.

Next comes a process called "fulling." You know how blankets and stockings thicken up and grow smaller if washed in hot water. This is because the fibres of the wool are "crinkly" and draw themselves up into closer "crimps" when the hot water touches them. The manufacturers take advantage of this to make the cloth thick and strong.

The cloth to be fulled is well soaked with soap and hot water, and pressed and rubbed between machine-rollers. In the making of broadcloth the fibres are "milled" or "fulled" so much that they become matted

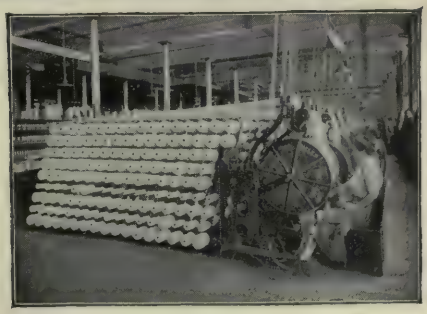
together. All cloth taken from the fulling machine must be stretched by hooks on a frame, else it would dry unevenly and be wrinkled and curled.



(1) DRAWING IN WARP THREADS (2) WEAVING (3) SCOURING CLOTH

The wiry sharp fine hooks, or awns, of the thistle-heads, known as teazels, which are imported from France, are used to raise up the fibres of wool, or teaze the surface of the cloth exposed to their action, into a velvety pile, or nap, just as the harrow works in spring.

There are two varieties of teazels, the wild and the cultivated, growing to the height of four or five feet. The wild kind is of no service, as the awns are weak and easily broken. In the cultivated teazel, the awns



(1) RING TWISTING
(2) BEAMING AND YARN INSPECTING

are closer set and of a stronger texture. The head of the teazel is covered with awns, curving back towards the stem like the teeth of a shark.

In the factories the teazel heads are placed in a small rack or frame, holding thirty or forty heads and

called a handle. The stalks peeping through are shaven off close and the teazel rack is ready for duty.

These simple thistles are more durable than any one would imagine; the wet elastic awns, if bent, leap back into position when dried, so they can be used many times over.

The handles are fixed round a wooden cylinder, which the cloth passes quickly over, while a jet of water plays upon it that the teazels may have a moist surface to work upon.

Sometimes, instead of teazels, the cylinders are covered with tiny steel hooks.

After this, the cloth passes through the cutting-machine or shearing engine, which shears the nap off close, leaving a smooth face to the cloth. The shears act on the same principle as our lawn mowers. The cutting part consists of a roller, round which wind spiral, sharp edges which, while revolving, meet, in turn, a fixed, straight blade, and act as a succession of scissors. The cloth, hooked across its breadth with half a dozen hooks, passes under the cutting blade and comes out as clean as a fresh-shaved chin.

For a whole day it is "squeezed," to take out the creases, bring the bulk down, and leave the cloth ready for finishing. Another examination for any imperfections follows; the cloth is measured, packed and tagged and is ready for the market.

Among the many varieties of woolen and worsted fabrics on the market are the following:

Broadcloth, so called from its width, usually sixty inches, is a closely woven material, with a soft, satin finish. When it comes from the loom it does not have the smoothness and luster which we see in the finished goods. These are obtained by first subjecting it to the action of the fulling mill, which results in the fibers of the warp and weft becoming so entangled that the cloth never unravels. Then it is napped and sheared close to produce a smooth, even surface. After this the cloth is wet, steamed, calendered, and hot pressed. For men's wear, the wool is dyed before weaving, while the broadcloth used for women's clothing is dyed after it has been woven, and is of a lighter weight. The best qualities of broadcloth are known as satin broadcloth. The heavy broad cloths are generally black or dark blue, while the lighter weights come in nearly all shades.

Cheviot, originally a rough woolen cloth, takes its name from the cheviot sheep, from whose strong, coarse wool it was first made in England. There are now two kinds, woolen cheviot and worsted cheviot, the latter being woven in fancy effects as well as in plain colors. The material is sometimes finished with what is known as the "rough" finish, and sometimes with the "close" finish. The same methods are employed in finishing both styles. When the pattern

is woven in diagonal stripes or lines the fabric is known as Diagonal Cheviot. Cheviots are used for both men's and women's suitings.

Flannel is a fabric which is made from cotton, from wool, or from both combined. It is loosely woven and of light weight, having an unfinished surface without luster.

Dress Flannel or **Flannel Suiting** is an all-wool flannel, of which there are several qualities and styles of finish. It comes in nearly all colors, and is usually "double width," the widths ranging from twenty-six to fifty inches.

French Flannel is a fine, soft flannel, woven with a twill. It comes in plain colors in delicate shades, and is also printed in figured, striped and flowered designs.

Baby Flannel is woven from fine, soft wool and is of very light weight. It is pure white, with a smooth surface.

Shaker Flannel is a white flannel woven with cotton warp and woolen weft, and finished with a napped surface.

Navy Flannel is a twilled flannel of heavy all wool. It is dark blue in color, and is used for making shirts for firemen, sailors, miners, etc.

Serge is a name given to many fabrics of twill weave. The serge of to-day resembles flannel in weight and

texture, but it is twill woven from fine yarn, and finished with a smoother surface than flannel. Serges are made of worsted, of silk, or of cotton yarn, finished in a variety of ways. Worsted serge has been in use since the twelfth century, and about four hundred years later came into general use as a material for men's wear. The name is from *sergea,* an Italian word meaning cloth of wool mixed with silk. The serge used for women's dress goods and suitings is passed through a pair of metal rollers after it has been dyed. The pressure makes the surface of the goods more regular and even, and gives it a greater luster, but will also produce a bloom on the surface which will cause spots to show on the goods if it is wet by rain. Storm serge is a coarse worsted fabric, with a wider twill and a rougher surface than the ordinary serge. It will not show rain spots, as the bloom on the surface is deadened by steaming the cloth. Mohair serge, woven with a cotton warp and a mohair filling, is used for lining in the manufacture of men's and women's clothing. Serge de Berry, a high-grade serge for women's wear, is soft and fine, and woven with a fine twill.

Tweed is a rough, unfinished cloth, made of wool or cotton and wool. It is usually woven of yarn of two or more shades, and the face of the cloth has an unfinished appearance rather than a well-defined pattern. Tweed taken its name from the River

Tweed in Scotland, it being originally woven on the bank of that river.

Beaver is a heavy woolen cloth, with a surface resembling the fur of the beaver. It is woven from fine wool, and used for overcoats and other heavy garments.

Kersey is a heavy, felted woolen cloth, having a satin finish. It takes its name from a town in England, where an extensive woolen trade was once carried on. Originally, kersey was woven from fine merino lambs' wool for face, with a coarser grade for back, but cheaper grades are now manufactured. It is a firm cloth, with a high luster, and will not wear rough or threadbare.

Melton is a thick, heavy woolen cloth, with a short nap, and rough to the touch. Meltons are woven single and double, and are usually dark blue or black in color.

Frieze is a thick, warm, woolen cloth, having a nap forming little tufts. At one time it was made from lamb's wool, but coarse grades of wool are now used in its manufacture. It is woven plain, with a small twill, or in a herring-bone pattern. Irish frieze is noted for its wearing qualities. The material comes in solid colors and mixtures, and is used for heavy overcoats, ulsters, etc.

Cashmere is made from the hair of a goat, known as the Cashmere goat from the fact of its home being in

the Vale of Cashmere in the Himalaya Mountains. The face of the cloth is twilled, the twills being irregular, due to the unevenness of the yarn.

Henrietta, so named in honor of Queen Henrietta Maria of England, is a twilled cashmere, highly finished and light in weight. Henrietta was first made in Yorkshire, England, with silk warp and wool filling.

Melrose, a double twilled fabric of silk and wool, takes its name from Melrose, a town in Scotland, on the Tweed.

Vicuna, made from the wool of the vicuna, an animal of South America, is a soft wool cloth on the cheviot style.

Alpaca is a fabric made from the hair or wool of an animal of that name, mixed with cotton or with silk. It is used for clothing in warm climates, for coat linings, and quite extensively for umbrellas. There is a material sold under the name of alpaca which contains little, if any, alpaca-wool. It is made of cotton and wool, with a hard and somewhat shiny surface.

Mohair Brilliantine is a fabric somewhat like alpaca in appearance, but with a greater luster, and is sometimes finished on both sides. It is woven from the long, silky hair of the Angora goat, either in a plain ground, or with figures. When a very lustrous material is wanted the warp yarn is of finer counts than the filling yarn.

Sicilian, also classed as brilliantine, is made with a heavy cotton warp and mohair filling.

Gloria, a fabric of plain weave, used for umbrella coverings, is made of silk and wool, and also of cotton and wool.

Homespun is a rough woolen material, loosely woven from coarse yarn, in imitation of the homespun cloth made by hand before the days of textile machinery. It is usually of plain weave, without felting.

Empress Cloth, a fabric similar to poplin, is woven with a hard twisted worsted filling and a cotton warp. It owes its name to the fact of its being a favorite material of Empress Eugenie of France.

Albatross is a fabric in which worsted is used for both warp and filling. It is woven in fancy effects, with open texture.

Panama Cloth is a worsted fabric of plain weave, made and finished in various ways.

Voile is another worsted fabric, made with a plain weave from hard twisted yarn. The cloth is finished with as clear a face as possible, it being singed or sheared closely if the yarn has not been freed from loose fibers before weaving.

Whipcord is twill woven from hard twisted worsted.

Bedford Cord is a fine woolen cloth, having lengthwise cords, with spaces, or recesses, between the cords; it is used for women's suits. For men's wear it is an all wool cloth of close texture.

Venetian Cloth is a worsted fabric, although sometimes a cotton warp is used in its manufacture. The warp yarns are firmly twisted, the twist being in the opposite direction to the twist in the filling yarn. The name Venetian is from Venetia, a country round Venice, and is a trade term given to various fabrics. One of the varieties is twill woven in lines or twills of a rounded form, arranged in a more or less upright position, thus constituting a closely woven worsted cloth. Venetian cloth has the same lustrous finish as broadcloth, but it has not so much filling, and shows the weave more.

Challis or **Challie** was originally a fabric of silk and wool first manufactured at Norwich, England, about 1832. It was thin, soft and fine, without luster. The name is now given to a light-weight all-wool material, woven without twill, and either plain or figured. French challis is sometimes made with a lustrous finish.

Zibeline is a cloth in which the warp is of Merino lamb's wool, with a mixture of light wool and camel's hair for the weft; it is also made with a worsted warp and camel's hair weft, and sometimes with either of these

warps a combination of wool, camel's hair and fine cashmere is used. The surface of the right side of the goods is covered with long hairs, some grades having the appearance of fur. The name, zibeline, is from *sabellum*, the Latin for sable, and was originally given to a long-haired fur supposed to be the same as sable.

Boucle is cloth woven from curled hair or wool in such a way as to show the curl. The name is from the French word for "curl."

Astrakhan Cloth is a rough fabric, with a long and closely curled pile. It is made to imitate the fur of the Astrakhan lamb.

Chinchilla is a thick, heavy cloth, used for winter coats for both men and women. It has a long napped surface rolled into little tufts in imitation of the chinchilla fur.

Other woolen fabrics are: Bunting, Beige, Castor, Chudah, Covert Cloth, Delaine, Grenadine, Hop Sacking, Linsey Woolsey, Merino, Mackinaw, and Tricot.

CARPETS

PERSIA has always had the fame of manufacturing the most beautiful and durable carpets; and next to that country, the carpets of India and Turkey are most esteemed.

Carpets of all grades and patterns are turned out yearly from our own busy looms.

In old times carpets had to be woven in hand-looms, but different machine-looms have been invented until, in these days, we have a different machine for every different kind of carpet.

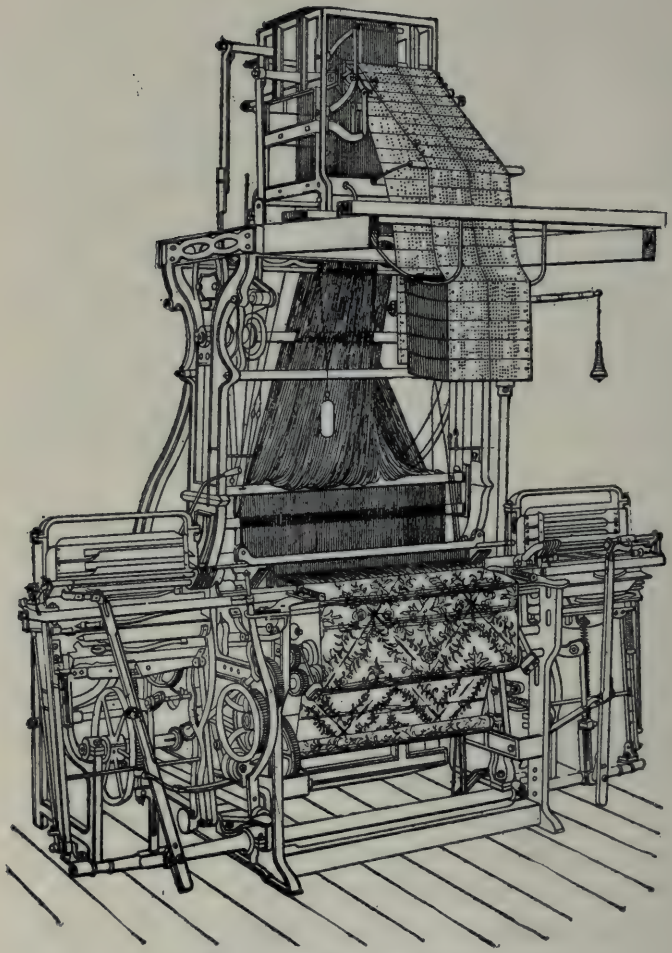
The "Scotch" or Kidderminster carpet is woven with a worsted warp, and a cotton or woolen weft, and is woven in pieces about a yard wide. Two colors are generally woven into this kind of carpet, and it is made in two webs woven together.

"Brussels" carpets are woven in many different colors. Each color has its layer of thread, running from end to end of the web.

The figures are raised by wires passing between the linen foundation and the bright worsteds. These wires are afterward taken out and leave a looped surface.

Wilton carpets are woven in the same way, except that the worsted loops are cut open, so forming a velvety pile.

In tapestry carpets a pile is made as in Brussels,



CARPET WEAVING.

but only a single thread is used in texture, instead of the five or six which are run through the Brussels. In the tapestry the threads are colored before they are woven.

Supposing a rosebud must be made a thousand times in the length of the web at intervals of four feet; a thread, just the length of the web, is wound round a hollow cylinder and a wheel, filled with the right color, is passed around the worsted coil. The thread, when uncoiled, will be found to be marked in a thousand places just where it is wanted to tip the bud with red from end to end of the web.

Design paper, upon which the design is indicated in small squares, serves as a guide to the colorer, for one square means just one stroke of the color-pulley. After the threads are streaked they are removed and the dyes are fixed by steam.

The cards you see at the top of the machine in the picture are perforated to produce the design. These cards are upon a cylinder. When the weaving commences the card cylinder begins to revolve, bringing up the cards on the inside of the frame.

When the needles enter the holes in the cards a bar descends, catches hold of these hooks and, rising again, draws them upward. As they are lifted, an opening is made for the shuttle to pass through with the crosswise threads.

Rugs, table covers, velvets and tapestry hangings are manufactured in the same way.

FROM THE EGG TO THE MOTH—LIFE HISTORY OF THE SILK WORM
(Courtesy of Cheney Bros., Connecticut)

IN A JAPANESE SILK FACTORY

SILK AND SILK MANUFACTURE

THE raising and manufacture of silk are very ancient arts, said to have first originated in China. In 2650 B. C. the Empress Si-ling-Chi is said to have invented the industry and was placed among the Chinese divinities as "Sien-Thsan," that is, "The first promoter of Silk Industry."

From thence the arts are said to have found their way through India and Persia to Europe, arriving there about 550 A. D., though they do not seem to have become well established in Europe before the Twelfth century.

Our ancestors were in this country only a short time before they began to attempt to plant the industry in

America. In 1624, we find in the colony of Virginia, numbers of skilled men imported from France to start the raising of silk worms. In the year 1649, there was published in London a pamphlet called, "A Perfect Description of Virginia," in which it said, "It surely would be better to grow silk here where mulberry trees are so plenty, than to fetch it, as we do from Persia and China, with great charge and expense and hazard, thereby enriching heathen and Mahumetans."

Connecticut was very early in the field, and in 1747 Governor Law appeared in silk coat and stockings, the silk for which is said to have been raised on his own place. From that time to the present day, there have been countless efforts to start the raising of silk in this country, sometimes by the aid of government bounties, sometimes without.

They have extended from Maine to Florida, to California, and all have failed from various reasons, chiefly on account of the cost of labor, which in Europe is paid from twelve to thirty cents per day, while in Asia as low as even two cents per day.

Between the years 1837 and 1840, there was the wildest of speculation in mulberry trees throughout the country. Just previous to this time of speculation the Cheney Brothers first became interested in the raising of silk worms, and later in the sale of mulberry trees. Both failed, but in 1838, one of them started a small plant to make sewing silk, at South Manchester, Conn., in which he was afterwards joined by his

brothers. This was the beginning of the first really successful silk factory in this country; a business which has grown until to-day the firm employs about 4500 operatives and occupies thirty-two acres of floor space.

The raising of silk in this country has been a failure, but the manufacture has increased with great rapidity during the years since 1850. Of recent years, competition in the United States has become very close and fierce, so much so that in the last two or three years, when other prices have risen to such a great extent, the prices of silks have actually decreased.

China, Japan and Italy are the greatest producers of raw silk in the order named, and China, United States, France, Japan and Germany are the great manufacturers or consumers of raw silk also in the order named, or the United States is now the second silk manufacturing country in the world, and is greater even than France, Italy and Switzerland combined.

The States most largely engaged in the manufacture are New Jersey, Pennsylvania, New York and Connecticut, but there are factories in many other parts of the country. In recent years a number have been started in the Southern and Western States. These factories employ nearly 100,000 people. There are 843 silk factories, not including cotton and woolen factories, which make silk mixtures.

Silk is the product of cocoons made by the silk worm, which is found in the countries enumerated in the list of silk producers given. The food of silk worms is the

A COCOONERY
(Courtesy of Cheney Bros., Connecticut)

leaf of the mulberry tree, though there are certain coarse wild silks, such as tussahs, found in China, Korea, Japan and India, the worms producing which live on the leaves of certain species of oak and chestnut.

The color of the cocoons varies greatly. Most of the Europeans are bright yellow, though some are white. The Eastern cocoons, on the other hand, are mostly white, while a very few are yellow. The wild silks are for the most part ecru color, though some are pale green. This color, except in the wild silks, is derived from the gum secreted by the worm, with which the fibres are stuck together. It comprises from 15 to 30% of the weight, and is removed by boiling in soap and water before the silk is dyed. All silks, except the wild silks, after the gum is removed, are from white to cream in color. The tussahs, or wild silks, remain an ecru color.

The greatest care has to be exercised throughout in the care of the moths, eggs, worms and cocoons, such being the succession of changes. That is, the moth lays eggs which are collected and kept cool till the proper season for incubation, when they are kept warm during the time occupied in hatching, sometimes about the person of the raiser. After a time these eggs hatch out worms, little tiny things hardly bigger than a pin-head. After the worms are hatched, they require constant care and feeding with chopped mulberry leaves till they reach maturity, about thirty-two days after hatching, during which period they moult or

change the skin three times. When grown they are about three inches in length, and spin their cocoons from a fibre and gum which they secrete. When the cocoons are spun, the worms become chrysalides inside of them. The cocoons are then collected and the chrysalides killed, generally by heat, before they can again become moths.

REELING SILK IN JAPAN

The cocoons are then sent to the reelers. A number of cocoons, greater or less, according to the size of thread desired, are placed in a basin of hot water, which softens the gum. After the outside fibres are removed so that the ends run free, just as you would unwind a thread from a ball, the ends are collected together through a guide and wound up on a reel. As

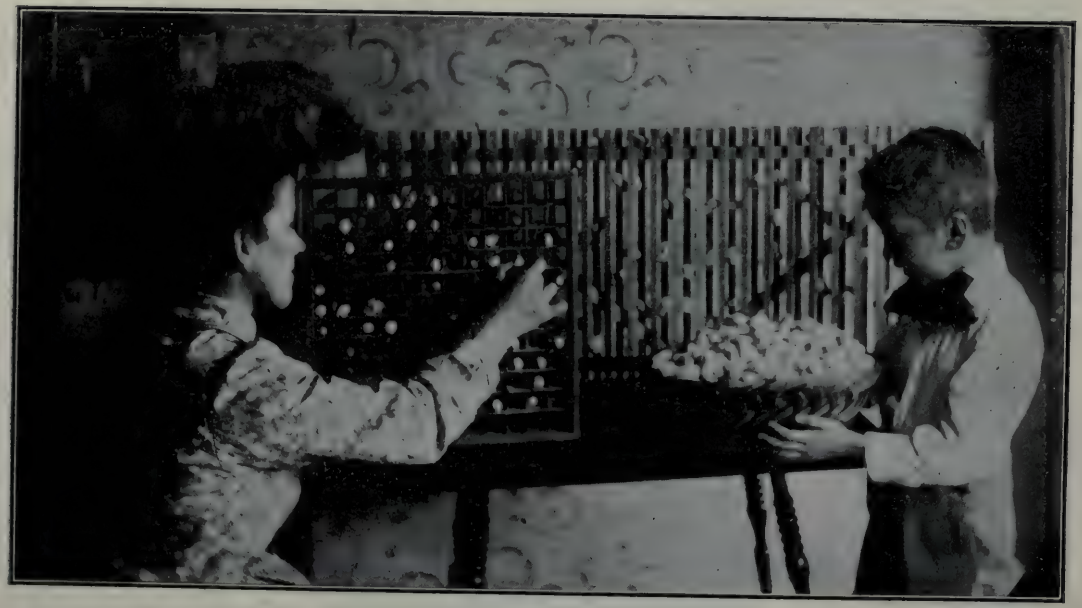
the silk cools and dries, the gum hardens, sticking the fibres from the different cocoons together in one smooth thread, varying in size according to the number of cocoons used. The finest sizes reeled are but little coarser than a spider-web. An 8-10 denier silk runs 491,000 yards per pound, or a pound would stretch 297 miles. It is seldom reeled coarser than 28-30 denier, which runs about 150,000 yards per pound. The silk in this state is known as raw or reeled silk; practically none is produced in the United States.

From this point, raw silk, the manufacture in the United States begins. We import our raw silk chiefly from Italy, China and Japan. It is handled here first by the throwster, who winds it from the skein and makes various kinds of thread for different purposes.

Raw silk wound on spools in a single thread and called singles is often used to make warps (that is, the threads running lengthwise of a piece of cloth) for piece dyed goods, or cloth which is woven with the gum in the silk and afterward boiled out and dyed. Singles are also sometimes used for filling (that is, the cross threads), in very thin fabrics.

Organzine is usually used for the warps of yarn-dyed goods; that is, goods the threads of which are dyed before weaving. To make Organzine, the raw silk is wound, then twisted in the singles, two or three or more threads put together twisted in the reverse direction, then reeled into skeins for dyeing.

Tram is used for filling of either yarn or piece-dyed



GATHERING COCOONS

(Courtesy of Cheney Bros., Connecticut)

goods, also sometimes for the warps of piece-dyed goods. To make tram, the raw silk is wound; two, three or more threads are put together and twisted, generally rather slack twist.

Crepe yarn is used in making crepe, in chiffon, and for other uses. It is very hard twisted thread, generally tram, from 40 to 80 turns per inch.

Floss Silk, not used for weaving, is a very slack twisted tram, generally composed of a large number of threads of singles.

Embroidery silk is made by winding the raw silk, putting a large number of ends together, giving them a slack twist, doubling and twisting in the reverse direction with a slack twist.

Sewing silk is made by winding and doubling the raw, twisting into tram, hard twisted, doubling and twisting in the reverse direction, drawing under tension at the same time it is twisted. Machine twist is similar, but 3 ply.

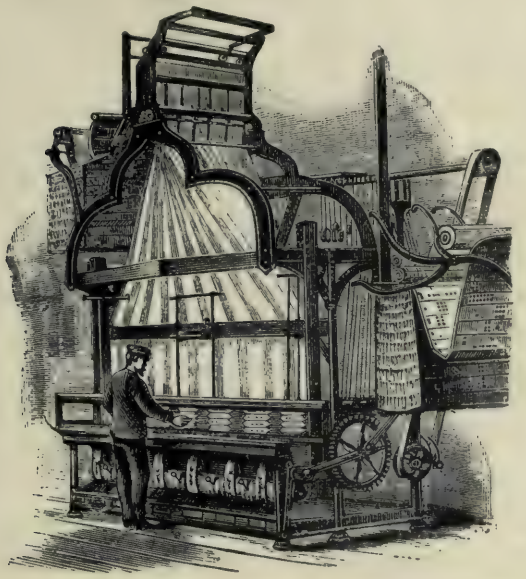
Spun Silk. There is another class of threads made from silk other than those made from raw or reeled silk, namely, those produced from waste silk by spinning and known as spun silks. Waste silks are the pierced cocoon, that is, those from which the moth has come out by making a hole and breaking the fibres in one end of the cocoons; also the waste made in the filatures in producing raw or reeled silk, chiefly the outside fibre of the cocoon and the inside next the chrysalis, and the waste made in manufacture.

Dyeing Yarns. Generally speaking, there are two large classes into which silk goods may be divided, those in which the threads are colored before weaving and called yarn-dyed goods, and those dyed or printed after weaving and called piece-dyed or printed goods. In dyeing yarns, the silk is first ungummed and cleaned by boiling in soap and water, then washed in cold water. If the thread is to be weighted, as is very frequently done, tin salts, iron or other heavy material is deposited on the fibre. If carried far, this is very injurious, making the silk tender and weak. Sometimes there is more weighting than silk. Yarns are usually dyed in hot liquors, aniline colors being the ones in most common use today, though other dyes are used for special purposes. Some yarns are dyed in the gum, and some, called suples, with a part of the gum left in. After dyeing, they are washed in cold water, dried and wound on spools.

At the present time practically all figured or brocaded goods are woven by the use of the Jacquard machine, invented by Joseph Marie Jacquard, of Lyons, France, about the year 1800. In this machine each thread of the warp passes through an eye which is attached to a cord, in its turn attached to a hook. These hooks are controlled by paper cards with holes punched in them which either push the hooks back, or if holes are punched, allow them to be lifted by means of blades which rise and fall between the hooks. By the use

of such machines very large patterns with great variety of weaves may be produced.

The most primitive method of printing on silk is by the use of stencils. It is the method employed by the



JACQUARD LOOM

Japanese and Chinese. Next came block printing, which is still extensively employed in Europe. The pattern is raised in felt on wooden blocks, the color taken up from pads, one block for each color. The results are good, but the work is very slow. Most silk goods are to-day machine printed. The design is engraved or etched on copper cylinders, one cylinder for

each color, the color thickened with gum, is supplied by rolls running against the cylinders and the surplus is scraped off by a knife blade, leaving only that in the engraving, which is taken up by the cloth. After printing, the cloth is steamed, to set the colors, and then washed, in order to remove the gum used to thicken the colors for printing.

All silk goods, whether yarn dyed, piece dyed or printed, are given some kind of finish; sometimes it is no more than is necessary to smooth out the wrinkles. But there are a great many such processes by which goods may be treated. They are run through gas flames to singe off loose fibre, over steam cylinders to dry and straighten them, over a great variety of sizing machines to stiffen them with starch or glue, calenders or heavy rolls to smooth and iron them, steam presses of great power to press them out, breaking and rubbing machines to soften them, tentering machines to stretch them to uniform width. There are also moireing, or watering, embossing and various other machines for special purposes.

How complicated and numerous are the processes for treating silk goods, may be realized when a piece of goods, piece-dyed or printed, is handled its entire length between fifty and one hundred times after it comes from the loom, sometimes even more.

While we cannot mention all the various silk fabrics, in the Appendix you will find a list of the principal weaves now on the market.

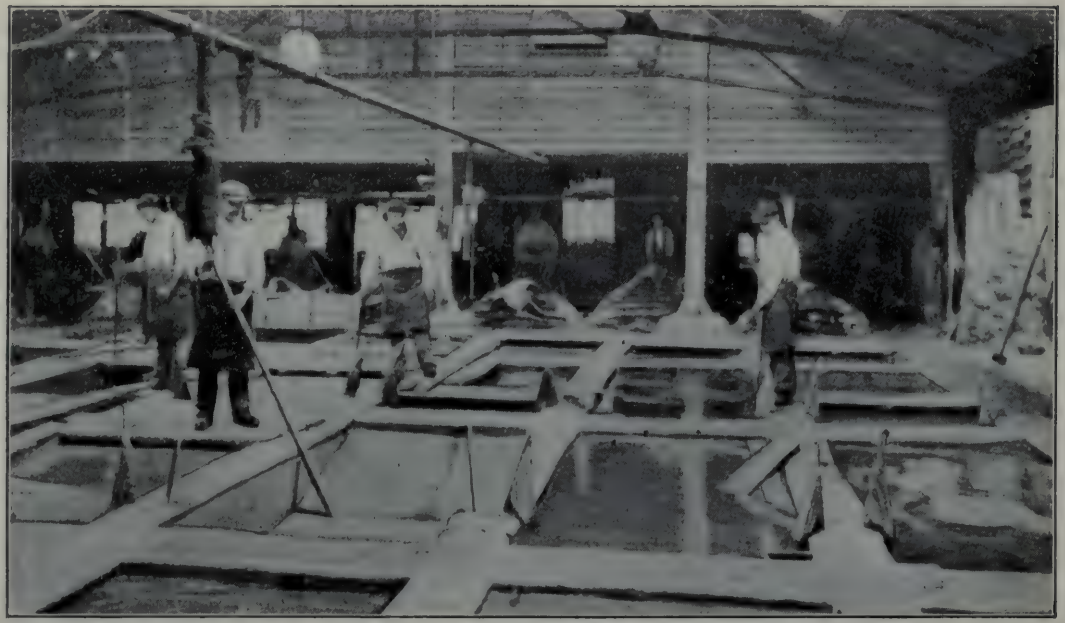
LEATHER

LEATHER consists of the hides and skins of animals, prepared by mechanical and chemical means for the various uses of man. Skins in an unprepared moist condition very soon have a tendency to rot; on the other hand, if dried raw, they become hard and horny, and useless for the clothing of man.

Commercial leather is made by three processes; first, tanned leather in which the hides and skins are tanned with tannic acid; second, tanned leather in which skins are prepared with mineral salts; third, shamoyed leather, consisting of skins combined with oils or fatty substances.

The skins of all animals may be made into leather, but in practice it is only a few of the larger animals, readily obtainable in sufficient numbers, and reared and slaughtered for other purposes, from which supplies of leather are obtained.

The term hides is restricted by the leather trade to the large and heavy skins of cows, horses and other large animals; all the lighter leather being known as skins; calf skins, sheep skins, goat skins, etc. Of all hides and skins used in commerce, by far the most important and valuable are those obtained from the common cow. Not only do these yield the most useful and valuable hides, but they are slaughtered in all civilized countries in enormous quantities. While in the



VIEW IN A TANYARD

The Liming Pits, where the hides are soaked

United States, the skins of cattle are now of secondary importance to the farmer, they are a very important source of revenue to the slaughtering houses.

The United States is the leading country of the world in the manufacture of leather, both in quantity and the quality of its product. Its tanneries produce enough to supply all home markets, and also to enable them to export large quantities. This requires more hides than can be obtained from the meat-packing industry in our own country, and the balance is supplied from the countries of South America, mostly from the Argentine Republic. Our annual output of leather exceeds $500,000,000 in value.

The hides come to the tanner in different conditions: the *green* or *raw* hide from the local market; wet salted hides; dry salted hides; and sun-dried or flint hides; the three last forms being the condition in which the imports of foreign hides are made.

The first operation in the tannery is to clean the hides, to free them from salt, and to bring the hard, dry hides to the uniformly soft condition in which all local hides are obtained. They are generally soaked in lime water or brine for this purpose. Then the hair is removed, either by men with long knives, or by machines with a large number of small revolving knives. Again the hides are cleaned, and trimmed to uniform size. Then comes the tanning process, which consists in placing the hides in a series of pits containing the tanning liquid.

They are first put into pits containing but very little tannin, but some acids and coloring matter. Here the hides are suspended over poles laid across the pit. Every day they are moved forward to a new pit and every new pit contains more tannin than the last. This is done to color the hides and remove the last traces of lime.

When, at length, the skins come out, looking very much like real leather, they are dried and pressed between rollers.

From the tanner the leather goes to the "dresser" to be dyed, or otherwise prepared for its final use.

The varieties of leather are due to the skin from which they are made, the method of tanning and the style of finish. The thick portions of the hides, which are along the sides and back, are used for sole leather, which requires no furthur finish after it is tanned, but the leather used for the uppers of shoes and for various other purposes is usually colored. The coloring is put on after the process of tanning is finished. Most leather used for boots and shoes is colored black, though various shades of brown, tan, gray and other colors, as well as white, are now being extensively used. The fancy varieties of leather are usually all made from sheepskin.

The art of leather-dyeing is of very great antiquity. Leather was known in the time of Moses; among the things to be used as offerings, Moses mentions rams' skins dyed red; and a covering for the tent of the

tabernacle was made of the same material. Leather carpets were then already used in tents.

Embossed goat-morocco straps have been found on a mummy of the ninth century B. C. Specimens of leather made up into shoes and sandals, and dyed red and yellow, and also specimens of leather dyed a maroon color, are to be seen in several Egyptian collections.

Red shoes were worn by the Romans, and it is recorded as being a singular habit on the part of Julius Cæsar that he wore red shoes on ordinary days.

To-day most of the old-fashioned dye-stuffs have, for ordinary leather dyeing, been entirely abandoned, the more easily applied coal-tar dyes being substituted. Machinery has also found ways of applying coloring matters to leather, thus considerably simplifying and shortening the old-fashioned dyeing processes.

In fact, the whole work of leather-dressing as carried out at the present time is so different from what it was in the time of our forefathers that it may be said to have been completely revolutionized.

Artificial Leather. The making of artificial or "manufactured" leather is also a great and growing industry. The shoe business, and especially the leather belting business (used for driving machinery), taking up so much of the supply of genuine leather.

To overcome this scarcity, substitutes for leather have long been in demand. So far the only manu-

factured leather that will meet the requirements of the upholstery, bookbinding, novelty, wall paper and similar leather trades as to price, appearance, uniformity and durability is that which consists of cotton fabrics coated with compounds and afterwards calendered and embossed in any desired grain or design. The fabrics may be sheetings, sateens, moleskins, drills, ducks, etc., either bleached or dyed to match the coating, and sized if necessary.

Alexander Parkes, an English chemist, in the early fifties of the last century, was one of the first to introduce pyroxilyn in connection with oil and resins for impregnating cloth to make it waterproof and pliable. Although the present process of manufacturing artificial leather rests on these old patents it took almost forty years to overcome all the difficulties in producing a flexible, non-adhesive, water-proof coating which at the same time had the necessary toughness with extreme pliablilty and plasticity to replace real leather in many instances.

One of the largest consumers of artificial leather both for upholstery and tops is the automobile industry. Most of the well-known automobile firms which manufacture hundreds of the low-priced popular cars a day have adopted it exclusively. All the other lines of furniture upholstery are using it extensively. Multicolored effects with dull finish in artificial antique, also called Spanish and mission leather, find ready and steadily increasing markets. Pocketbooks, handbags,

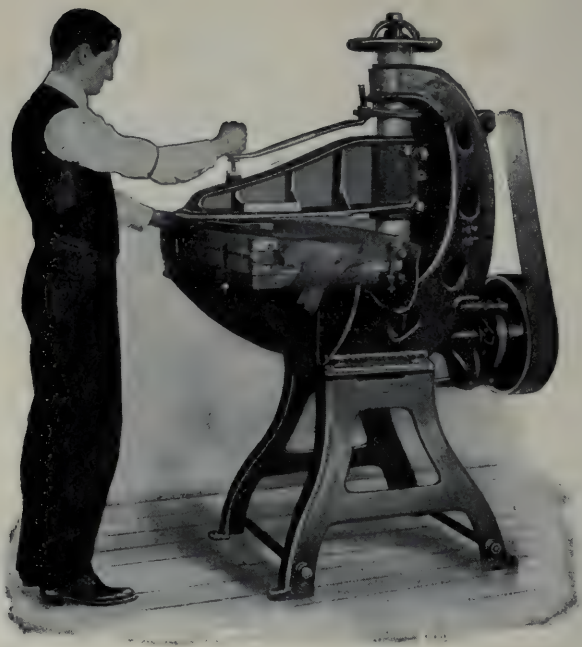
leather novelties in the cheaper grades are made entirely from the cheaper substitute.

It is especially well fitted for the production of staple leather goods on a large scale, due to its ability to be manufactured relatively cheap in any modern coloring and graining effect and in unlimited quantity and a uniform thickness throughout. Another great advantage is that it can be sewed much more easily with a machine than real leather of equal thickness.

Trunk and suitcase manufacturers are consuming great quantities of this substitute for real leather because of its waterproof properties. For the same reason it is used for sweatbands in hats and caps, for doll bodies, toys, bookbinding and wall paper.

No other wall covering is more sanitary and permanent than this because it is damp proof and can be cleaned easily with soap and water whenever desired. Grease, smoke and atmospheric influences do not affect it in the least. It can be made completely uninflammable and so decreases risk in case of fire. There are many other ways in which artificial leather may be employed, owing to the excellent qualities which give its adaptability a wide scope.

In fact, the keen competition in the leather trade the world over paves the way for the continual study of the inventor, and many bright boys and girls now in school will no doubt continue to play their part in the introduction of methods of perfecting leather to the benefit of the industry and mankind in general.



CUTTING UPPERS BY MACHINERY

BOOTS AND SHOES

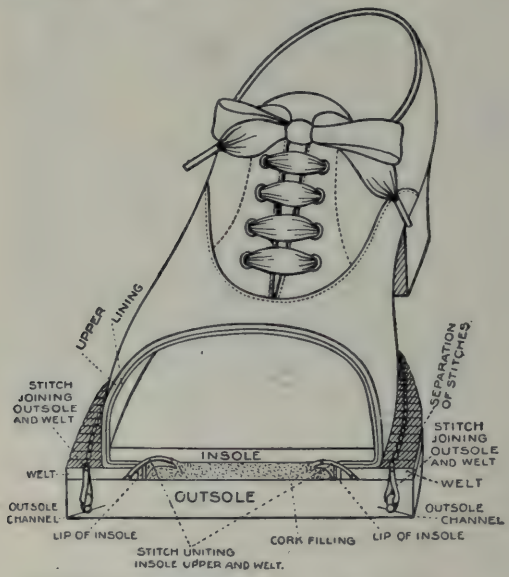
FORMERLY all boots and shoes were made by hand. Each shoemaker performed all the labor necessary to complete the shoes, and this method of manufacture continued until long after the Revolutionary War. For years it was customary for the shoemaker to travel from house to house with his kit of tools and make up the leather into such footwear as the family needed. When the country became more

densely populated, the shoemaker found it to his advantage to remain in one location and have his customers come to him. So the shoemakers built small shops, in each of which one or possibly two men worked.

The development of the boot and shoe industry, from these early stages to its present condition, is of great interest because it shows more clearly than the growth of any other industry what has been accomplished through the division of labor and specializing the occupations of workmen. It is considered that the boot and shoe industry is the most perfectly organized of any manufacturing industry in the country. This evolution had its beginning in the city of Lynn, Mass. This city and Brockton are the most important centers of the industry. There were many small shoe shops in Lynn in each of which all the processes necessary to the manufacture of boots and shoes were carried on. Several of the proprietors of these shops decided that it would be to their advantage to combine and divide the different processes among their workmen so that each man should give his attention to only one of the various processes. The result of this venture was so satisfactory that large shops soon took the place of the small ones.

The modern shoe factory is the result of the application of machinery to the manufacture of boots and shoes. As soon as the sewing machine was adapted to this work, it greatly increased the possibilities of the shoe shops, and this machine has now been adapted

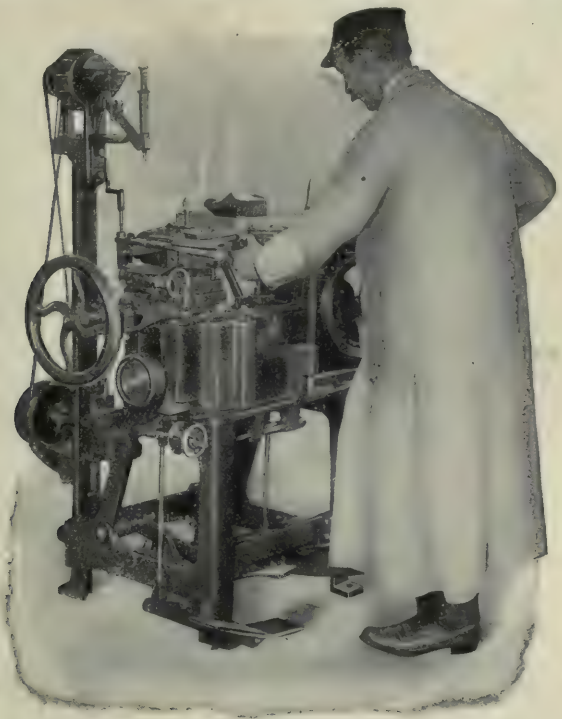
to all of the different uses to which a sewing machine can be put in the manufacture of boots and shoes. The invention of other machines has kept pace with the modifications of the sewing machines, so that now almost every process required to produce a shoe is performed by machinery.



THE CROSS SECTION OF A SHOE
Showing the different parts and their relation one to the other.
(Courtesy of United Shoe Machinery Co.

Massachusetts is the leading state in the manufacture of boots and shoes, but the industry is more generally scattered over the country than the textile industry. Large factories are now found in nearly all the important cities of the Union, and through the Central and Western States occasional factories are

seen in small towns. St. Louis and Cincinnati are the leading centers for the West and their production is rapidly increasing each year. As in the manufacture of leather, the United States leads the world in its



LASTING BY MACHINERY

production of boots and shoes, both as to quantity and quality. Our annual output exceeds 220,000,000 pairs, which is nearly three pairs to every man, woman and child in the country, and the value is some over $260,000,000; about $5,500,000 worth are exported.

METHOD OF TAPPING A PARA RUBBER TREE.
THIRD DAY AFTER TAPPING.

INDIA-RUBBER

(CAOUTCHOUC)

HOW many boys and girls know where rubber comes from? Do they dig it out of the ground? Does it grow on trees or bushes? Did you ever see any except what came from the stores?

I do not think you can guess, so I will tell you. Rubber, also called caoutchouc, is the dried, milky juice of various tropical trees and shrubs — plants that have a sticky sap in them, somewhat like milkweed. These plants and trees seem to grow best in hot countries, especially along the Amazon River in South America, where it rains a great deal.

The first notice of the peculiar qualities of india-rubber was made about five hundred years ago by the Spanish historian, Herrera, who, on the second voyage of Columbus to this country, saw the inhabitants of Hayti playing a game with balls made of the gum of a tree; balls that were lighter and bounced better than the "wind balls of Castile."

Not alone was the valley of the Amazon found stocked with rubber trees and vines, but new species were discovered in Central America and Mexico as well. In 1798 rubber-producing vines and trees were also found in Southern Asia, later on in Central Africa, and by the middle of the nineteenth century, almost every tropical country of the world had been searched.

A RUBBER VINE IN A PHILIPPINE FOREST.

Tropical America in the beginning produced nine-tenths of the rubber supply, but it now exports not one-half of the total amount. Central Africa, India, Burma, Borneo, the Malay States, Java and the Philippines, all have rubber vines and trees, and export great quantities. But the world is constantly calling for more and more. The bicycle and the automobile make an ever increasing demand, and every source of supply is being ransacked and many imitations also put on the market.

As early as 1755 Dom José, King of Portugal, sent several pairs of his boots to South America to be coated with rubber milk. They must have been made satisfactorily waterproof, for the rubber industry has increased from that day to this. But it was not until the middle of the last century that the many uses to which rubber could be applied was well understood and the rubber industry thoroughly established.

The scenes that surround the home of the rubber gatherer on the Amazon in South America, are weird in the extreme. Think of a forest whose silence is unbroken by the voice of man, where even the sunshine refuses to penetrate, and all is dark, gloomy and foreboding. Fierce jaguars, deadly serpents, birds of brilliant plumage, and the rubber gatherer are the sole tenants.

In a small thatched hut, built on piles — for his rude cabin nearly always stands in the water — is the dwelling-place of the half Indian, half negro, who taps

HOME OF THE RUBBER GATHERERS IN THE AMAZON VALLEY.

(Photo by Courtesy of The B. F. Goodrich Company Akron, Ohio.)

the rubber tree. Close by is the rubber grove, and thither the worker wends his way at daybreak to gather the precious gum. With a sharp instrument, somewhat resembling a hatchet, a number of incisions like a "herring-bone," are made in the bark of the tree and a diminutive clay cup is placed at the bottom to catch the flow. In many respects the operation is akin to the gathering of maple sap in New England.

The sap from the rubber tree flows into the cup, and at night the entire yield is brought to the huts, after having been gathered into one huge earthenware jug, or a calabash — the dried shell of the fruit of the calabash tree, which grows in the tropical parts of America. Some rubber trees yield from ten to thirty cups, and one worker may attend from one hundred and ten to one hundred and forty trees, so that a day's work is apt to be highly profitable.

The contents of the calabash now resemble a huge pan of milk, and to make from this the crude rubber requires skilful work, preparations for which have been going on meanwhile.

A smouldering fire of palm nuts is ready, the heat and smoke from which is to transform the gum into crude rubber. To concentrate this smoke a jug-shaped earthenware vessel, constructed to answer the purpose of a chimney, is placed over the fire, and through the hole at the top pours the dense smoke caused by the burning palm nuts.

The rubber-worker now takes an implement much

METHOD OF SMOKING THE GUM OF THE RUBBER TREE.

(Photo by Courtesy of The B. F. Goodrich Company, Akron, Ohio.)

resembling a long-handled wooden spade, the blade being round instead of square.

Dipping the blade end, or mold, as it is called, into the liquid gum, he gathers on it all the gum that will adhere, then holds it over the hot smoke to dry. Again and again he repeats this operation, until the rubber cake or "biscuit" as it is now called, is of the desired thickness. The cake of rubber is now cut from the stick and hung up to dry.

When a sufficient number of cakes have been obtained, they are sold to traders, who take them down the river in small boats and canoes. From whatever cause, the rubber thus prepared by smoking is considered the finest in the world. Rubber is grown in Africa, Asia, Mexico, Central and South America, and many other places, but only on the upper Amazon in South America is the finest grade of rubber produced.

Down the river go the lumps of crude rubber or biscuits, and they finally reach Para, the chief city on the Amazon.

Para is the great rubber city of the world. It is also the headquarters for all goods coming and going on the Upper Amazon.

The plantations of Ceylon, which term also includes other countries of the far East, however, are beginning to offer an annually increasing quantity of high-grade rubber, which for many purposes is considered equal to Para, being in fact the product of true "Hevea" seed imported from Brazil.

The gathering of the Ceylon product is similar in many respects to that carried out in Brazil, the difference in the finished product being caused by the curing process which is effected in Ceylon by means of a

SCENE ON A CEYLON PLANTATION

solution of acid, while the South American grower still relies on the smoking process, which it is claimed is superior in its results.

Ceylon rubber comes in thin sheets of lighter color than Para and is practically ready for use, the impurities having been removed during the curing process.

Leaving Para or Ceylon the rubber is soon on its way to New York, where swift sailing steamers quickly land it, and now begin the operations that transform raw rubber into rubber boots and shoes, automobile

tires, and the thousand and one things now called for by the modern world.

Much of this great business in the rubber industries, now carried on in every city of the United States and Europe, owes its existence to the energy and perseverance of an American inventor, Charles Goodyear.

For a great many years, up to nearly the middle of the last century, various attempts had been made to use rubber for the making of clothing, shoes, coats and hats, but they had not been satisfactory.

Daniel Webster used to tell of a rubber cloak and hat which a New York friend had sent to him at Marshfield. He took the cloak to the piazza one cool morning, when it instantly became as stiff as a sheet of iron. Finding that it stood alone, he placed his hat upon it and left the articles standing near the front door. Several of his neighbors who passed, seeing a dark and portly figure there, took it, as Mr. James Parton tells in an excellent story, for the owner of the mansion, and respectfully saluted it.

But the things that became as stiff as iron with cold, changed with heat to the consistency of molasses. When, at the advent of winter, they went to look for the gum shoes that they had put away in the spring, all they could find was a shapeless lump of something which resembled pitch.

How could this material, which promised so much through its water-proof quality, be manufactured so as to prevent it from hardening with the cold or soften-

BRANDING THE RUBBER BISCUITS BEFORE SHIPPING.

(Photo by Courtesy of The B. F. Goodrich Company, Akron, Ohio.)

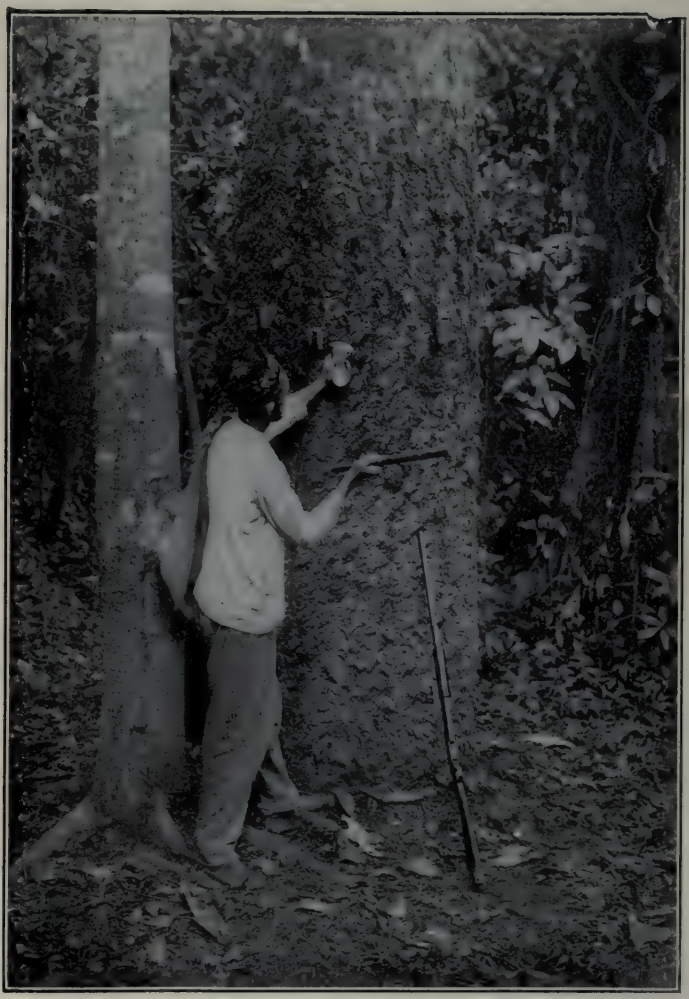
ing with the heat? That was the question which Charles Goodyear set himself to solve.

When the answer eventually came, Goodyear told of his struggles in a book made of rubber — a volume of six hundred and twenty pages, with covers of rubber and pages of rubber, no other material about it, inside or out, than rubber; which changed neither with heat nor cold, and possessed all the properties which had hitherto been wanting.

It cost him two millions of dollars to learn the secret, and the annals of invention contain no greater instance of heroic devotion and unfaltering hope than is afforded in the many links in the chain of experiments, by which he finally triumphed.

As he failed again and again, his friends forsook him; he was imprisoned for debt, and within the walls of the prison still continued his experiments. Often the secret seemed to be within his grasp, but as he reached for it, it would evade him.

One day he esteemed it a rare piece of good luck to procure some of the sap not smoked and still liquid. On going to the shed where the precious sap was deposited, he was accosted by a workman in his employ, who in high glee informed him that he had discovered the secret, pointing to his overalls, which he had dipped into the sap and which were nicely coated with firm India rubber. For a moment he thought that Jerry might have blundered into the secret. The man, however, sat down on a barrel



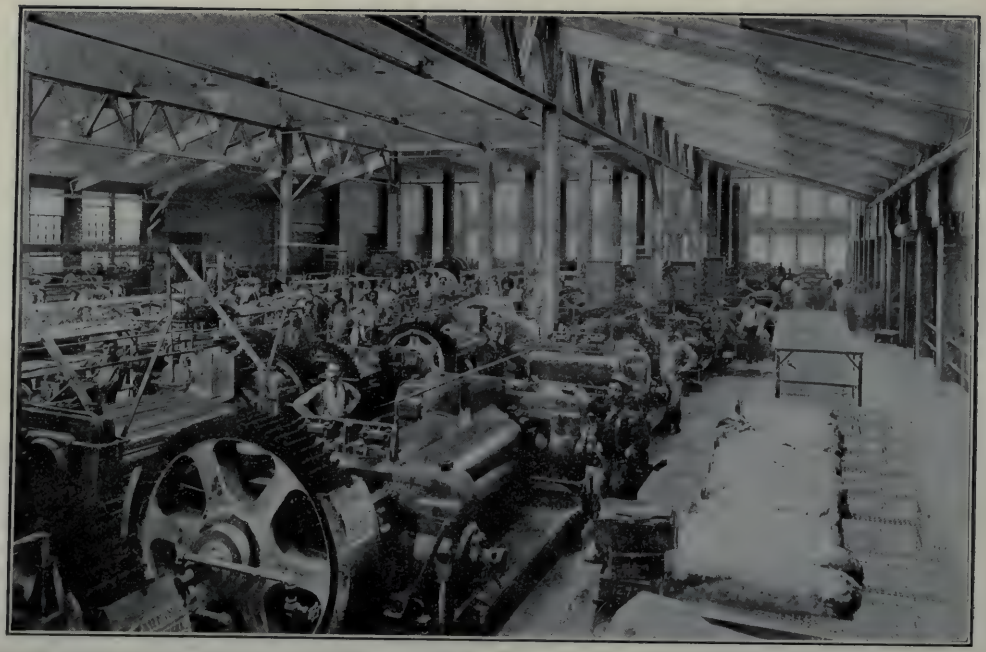
TAPPING A RUBBER TREE.
(Photo by Courtesy of The B. F. Goodrich Company, Akron, Ohio.)

near the fire, and, on attempting to rise, found himself glued to his seat and his legs stuck together. He had to be cut out of his overalls.

It was an accident at last that opened the way to discovery of the process of vulcanization for which Goodyear was seeking. At Woburn, Mass., one day, in the spring of 1839, he was standing with his brother and several other persons near a very hot stove. He held in his hand a mass of his compound of sulphur and sticky gum, about which he was arguing in his usual vehement manner — the company exhibiting the indifference to which he was accustomed.

In the midst of his argument he made a violent gesture, bringing the mass of gum in contact with the stove, which was hot enough to melt India rubber instantly; upon looking at it a moment after, he perceived that his compound had not melted in the least degree! It had charred as leather chars, but no part of the surface had dissolved. There was not a sticky place upon it. To say that he was astonished at this would but faintly express his amazement. The result was absolutely new to all experience — India rubber not melting in contact with red-hot iron! He felt as Columbus felt when he saw the land bird alighting upon his ship and the driftwood floating by.

In a few years more his labors were crowned with success. In the words of Mr. Parton, who has kindly placed his researches at our disposal, Goodyear gave to the arts not a new material merely, but a new class



MILL ROOM OF THE B. F. GOODRICH COMPANY, WHERE CRUDE RUBBER IS ROLLED INTO THIN SHEETS.
(This is the largest rubber mill in the world.)

of materials, applicable to a thousand diverse uses. His product had more than the elasticity of India rubber, while it was rid of all those properties which had lessened its utility. It was still elastic rubber, but its surface would not stick together, nor would it harden at any degree of cold nor soften at any degree of heat. It would make a cloth impervious to water; a paper that would not tear. It was like leather which neither rain nor sun would injure. It became like ebony run into a mold, or ivory worked like wax. It was better than wood that never cracked, shrunk, nor decayed. It was metal, "elastic metal," as Daniel Webster termed it, that could be wound round the finger or tied into a knot, and which preserved its elasticity almost like steel.

Trifling variations in the ingredients, in the proportions and in the heating, made it either as pliable as kid, tougher than ox hide, as elastic as whalebone or as rigid as stone. The increase in the value of the crude material and the importation of it can well be imagined.

If Charles Goodyear were alive to-day he could discover nothing connected with his invention in which so great an improvement has been made as in the manufacture of rubber shoes. In shape, durability, and comfort there is no comparison between those experimented on by him and those which are now shipped to every city, town, and village in the United States and to all parts of the world. The most dainty

Parisian fashions in footwear are reproduced in rubber with such perfection that the material has the appearance of the finest patent leather.

To see what American genius and perseverance can now do with these crude "biscuits" of rubber, let us follow a shipment to one of the great rubber factories.

But, when reading of or visiting any of these great factories, whether for the manufacture of cotton, or silk, or rubber, it is well to remember that they were not always great. They all had a beginning in the brain of some enterprising person.

One of the greatest rubber factories in this country, the Goodrich factory of Akron, Ohio, to which we will now pay a visit, was founded in 1869 by Dr. B. F. Goodrich in a small building with about twenty-five employees. To-day the business finds employment for about fifteen thousand workers, and the vast factory buildings have a floor space of about sixty-five acres. Many people are still alive who can remember the genial doctor as he journeyed around the country literally "building up" a business which (could he return) would now hold him spellbound by its immensity. Many such large businesses are just the result of pluck and persistency; qualities which every boy and girl should cultivate.

But to return to our factory. The rubber, on its arrival at its destination, is inspected, weighed and stored in darkened cellars. The reason of its storage underground is that rubber, whether crude or manu-

factured, rapidly loses its elasticity under the actions of light, heat or prolonged dryness. A dark, cool atmosphere offers the ideal storage condition in any stage.

Before the crude rubber is available for manufacturing it requires several processes of purification. The

RUBBER "BISCUITS" IN A CORNER OF ONE OF THE CELLARS

"biscuits" are fast put into vats of hot water to soften, then they are crushed between huge rollers, and from there taken to washing machines until all impurities are removed.

Now the pure rubber is again passed through great rollers, coming out as thin porous sheets, so that the greatest possible surface is exposed to the air.

As moisture has a bad effect on the manufactured rubber, the sheets are next taken to a drying room, and subjected to a slow drying, to remove every particle of dampness.

WASHING MACHINES

From the dry loft, the rubber, each lot of which has been tested by a chemist, goes to the grinding mills, where it is refined on warm rolls, and made ready for mixing. It is impossible to make out of rubber alone, tires, shoes or other articles that will withstand extreme changes in temperature; certain amounts of sulphur and other ingredients are necessary in combination with the pure rubber to give a satisfactory material.

So the gum from the grinding mills is taken to mixing mills, where, between large rollers, the various materials are compounded together.

The prepared rubber is now taken to the several departments to be worked up into the different products.

In the making of automobile tires, a cotton woven fabric, the same as in fire hose, is used as a foundation. This fabric is run through a calender, which impregnates it with rubber.

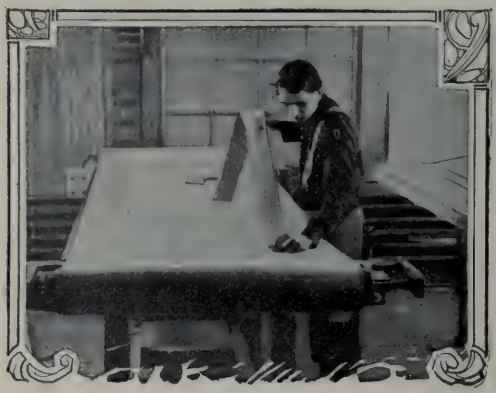
DRYING ROOM

The softened rubber, held in place by friction, gradually slides through the rolls, meets the fabric, and is pressed completely through its meshes. Next the coating calender applies a thin sheet of fine rubber that covers the entire surface of the fabric.

The fabric is now cut into strips, and built up, one over the other, to the proper thickness required for

the tire. For the large tires as many as eight plies of fabric are used.

The tires are now vulcanized or cured. This process requires the utmost exactness — over-cure makes the tire brittle and under-cure leaves it soft. Briefly, the process is this: The tire, still on the core or form, is placed in a mold made in halves. The mold and its contents then go into a heater where they are sub-



BUILDING SLABS

jected to uniform heat and tremendous pressure. The rubber is rendered pliable and, under the extreme pressure, rubber and fabric are welded into a solid whole. At the proper moment the tire is withdrawn from the heater, taken from the mold, stripped off the ring, and passed to the trimming room where the mold marks are removed. A coat of asbestos paint is applied to the inside to prevent sticking of the inner

tube. This is followed by a thorough scrubbing, which leaves the tire clean. A final inspection and the tire is wrapped and trucked away to the storage room.

In another department we see them making belts

INSPECTING CASES

to drive machinery, some of the belts measuring over five feet wide, and weighing over three tons.

Belts are built up in much the same way as are the pneumatic tires — with the alternating plies of fabric and rubber. The belts are rolled up with damp cloths between each layer. They are then placed in huge

iron cylinders to vulcanize the edges — then run through flat presses, and exposed to high pressure and temperature to complete the curing.

From the belt mill we can go to the hose mill, where fire hose is made and shipped to all parts of the world. To see the many different kinds of hose,

BELTING PRESS

built ply upon ply, for the special use for which it is intended, is certainly an interesting sight. The department, however, which will most interest boys and girls is probably what they term their *specialty department.* Hot water bottles, bags, druggists' rubber

sundries of all kinds, physicians' and surgeons' rubber supplies, bulbs for every purpose, sporting goods, tennis balls, tubing, etc., are included in its list of products.

It is really remarkable how very many different

ONE FLOOR OF HOSE BUILDING

"compounds" of rubber are necessary to produce the various articles made in any one department. Take, for instance, a water bottle and a tennis ball — the one, soft and almost flabby; the other hard, yet full of bounce. But to make even such a small article

as a golf ball requires no less than twenty-two different operations. First, the center — either hard, or soft, as required — is wrapped, each time with a finer thread, and a greater tension.

MAKING WATER BOTTLES

The cover, of selected gutta percha, is first molded in two halves. The core is dropped into one half — the other half dropped over it — and by means of a hydraulic press, heated to the right temperature, the

two halves of the cover are pressed together and cured at the same time. This press also gives the ball its marking, and only trimming and painting are required to make it the finished product.

This is only a hurried and brief sketch of the various operations which at every stage require skilled labor, wise supervision, and the use of the highest grade of material. It is well to remember, however, that each finished article is the result of countless experiments. There is no finality in the chemistry of the rubber industry and any process which will improve the output is speedily adopted. It is one of the most promising fields for the inquiring boys and girls of the coming generation.

SECTION OF THE SPECIALTY DEPARTMENT

EXPERIMENTAL GRAINS, NEAR REDWOOD, OREGON.

CORN, WHEAT AND MEADOW GRASS

NOW that we have seen how many things in nature contribute to our needs, and have gone through the different stages of manufacture to find out how our clothing is made, let us inquire where the food we eat comes from, and how some of the many things we enjoy are made and improved by the industry of those who labor for the world's good.

It is said that the *farmer* is the most important man in the world, because the chief necessaries of life are grown and thrive under his care, and without his knowledge and activity a great many useful and appetizing things might be lost to us.

Grass we might consider as being the staple of food, for it is from this class that we get wheat, corn, rye, oats, barley, etc., and consequently it is the most important of all vegetable products. People have always used the seeds of these plants for food. They grow in all countries where man lives. The seeds of all these grasses are properly corns, and because from the flour formed from them various kinds of bread are made, they are called bread corns; a grass which produces bread corn is a cereal. Barley is the hardiest

ONE OF SIXTY THREE LARGE GRAIN ELEVATORS IN MINNEAPOLIS, MINN

of all the grasses, and will thrive anywhere, even in the frigid zones. The ancient Egyptians believed it to be the first of the grasses used for food, and only two centuries ago it was the common food grain of England. It is prepared for table by *pearling the* grains, that is, peeling off the outer layer.

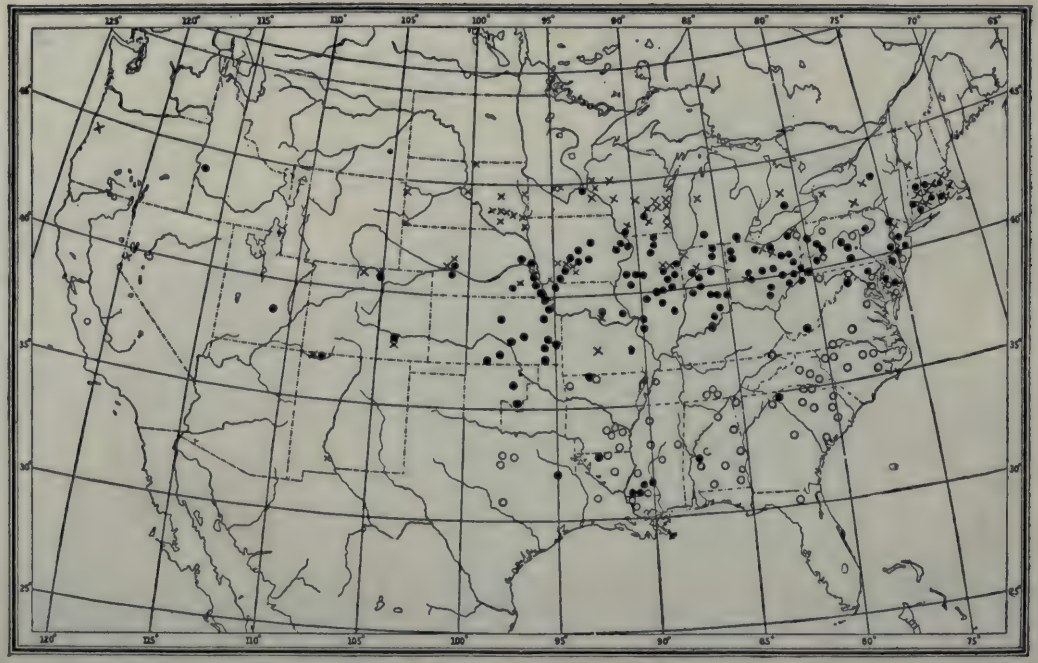
Rice requires a hot climate; it is very largely used, and forms the principal part of the food of one-third of the human race. Rice is mostly starch, and contains but little nourishment for the brain or muscles, consequently the nations living on this cereal are behind Americans and Europeans in almost everything useful.

CORN

Wheat ranks next to rice in importance, but in this country the most valuable cereal is Indian corn, or maize, as it is more properly called. It is a native of America, and was cultivated by the Indians long before the white man set foot upon this continent.

The color of the kernels ranges from white, through yellow, to dark red and even purple; the shape, from the tiny rice grains of the popcorn, to the long, sharp kinds of the South and West, and the wrinkled sweet kernels. One Rocky Mountain variety has a husk over each separate kernel.

The kinds most valued are the staple, the Indian-corn, the sweet, and last, but not least, I am sure, in your estimation, the pop-corn. It contains all the



Map showing distribution of three varieties of Corn. Cross (+) = Pride of the North. Spot (●) = Leaming. Circle (○) = White Gourd Seed.

qualities needed to sustain life, in one of the cheapest forms, but is mostly adapted for people of active habits of life.

The botanical name of corn is *Zea Mays*. Columbus is said to have brought it to Spain about the year 1500. The early settlers of America found maize growing in all parts of the country.

The varieties of corn are many, but they may be divided into five principal groups, *viz.*:

GROUPS AND VARIETIES

(*a*) FLINT CORN

(1) Angel of Midnight
(2) Canadian Eight-rowed Yellow
(3) King Philip
(4) Longfellow

(*b*) DENT CORN

(5) Bloody Butcher
(6) Golden Dent
(7) Hickory King
(8) Leaming
(9) Mosby's Prolific
(10) Pride of the North
(11) St. Charles White
(12) White Gourd Seed

DENT CORN — *Continued*

(*c*) SOFT CORN

(13) Squaw

(*d*) SWEET CORN

(14) Stowell's Evergreen

(*e*) POPCORN

(15) All varieties

For the past eighty years our corn crop has been constantly increasing, till now corn is the most important grain-product of the United States. The commercial value is perhaps best indicated by statistics. The reports of the United States Department of Agriculture for 1915 gave the total yield as over 3,000,000,000 bushels. This crop was valued at nearly $2,000,000,000.

The principal corn-growing region of the United

A CORN-BINDER AT WORK

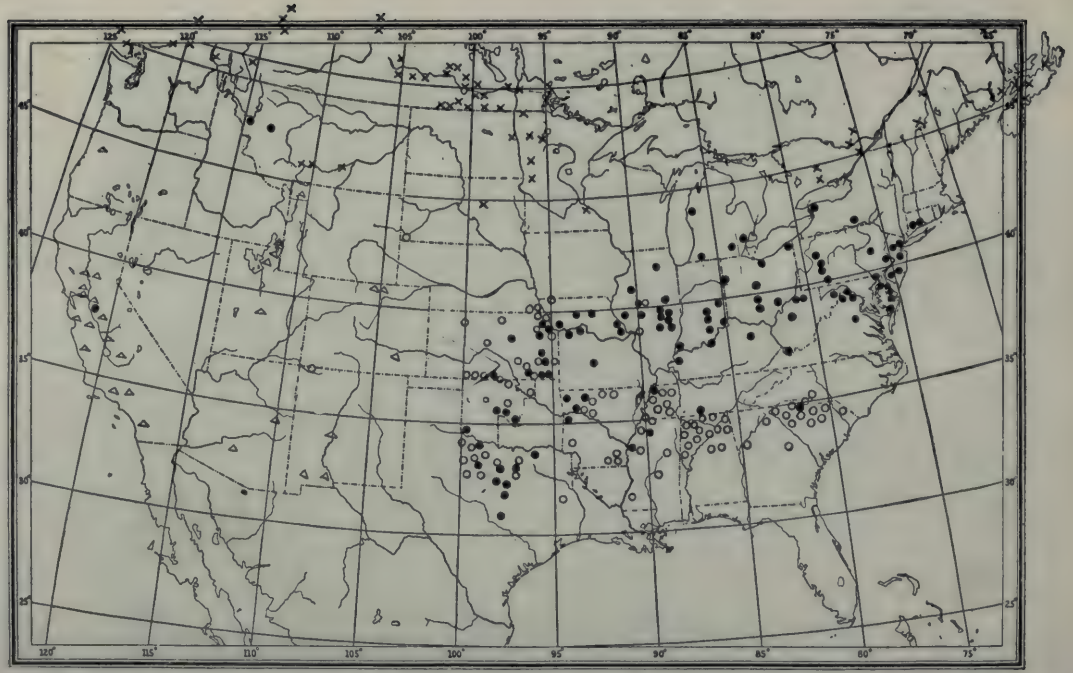
States comprises Iowa, Illinois, Missouri, Kansas, Nebraska, Indiana, Ohio, Kentucky, Texas and Tennessee.

The canning of sweet corn and the use of popcorn by

BROOM CORN

confectioners are also sources of considerable revenue to the farmers.

Besides being used as our food, corn is given to



Map showing distribution of four varieties of Wheat. Cross (+) = Red Fife. Spot (●) = Mediterranean. Circle (○) = May. Triangle (△) = Sonora.

animals, and is considered the best food for those whose flesh we eat.

The husks, dried, are used for mats, and for filling beds and cushions. The stalks may furnish fuel, thatch for roofs, or may be made into baskets. Paper has been manufactured from some portions. The cobs alone, or soaked in oil, are useful for kindling.

WHEAT

Wheat grows in all countries where the climate is temperate and the soil rich. The use of wheat has been steadily increasing since the discovery of America, from the fact that the bread made from it is more digestible than that made from any other grain.

Wheat has a large share of an elastic, tough substance called *gluten*, which is not found in any of the other grasses, and it is this gluten, combined with heat, and the addition of yeast, that enables a lump of dough to expand to a loaf of bread three times as large.

There are several kinds of wheat, but for ordinary purposes they may be divided into two groups, winter and spring, as follows:

GROUPS AND VARIETIES

(*a*) WINTER WHEAT	(*b*) SPRING WHEAT
(1) Clawson	(8) Australian
(2) Fulcaster	(9) Ladoga
(3) Fultz	(10) Saskatchewan Fife
(4) May	(11) Scotch Fife or Fife
(5) Mediterranean	(12) Sonora
(6) Turkey	(13) Red Fife
(7) Velvet Chaff	

TURNING AN ACRE IN FOUR MINUTES AND FIFTEEN SECONDS.
(At the Field Demonstration, Purdue University, Indiana.)

The quality of flour depends on the kind of wheat, and the mode of curing and grinding.

In former days, before machinery for cultivation was extensively used, a hundred acres was an extensive wheat farm. At present, with the labor saving devices which have been invented and have come into use since then, it makes possible the employment of hundreds of men in the cultivation of vast wheat fields. There are in North Dakota and California wheat farms of seventy thousand to ninety thousand acres.

For one man to plant such vast tracts, it would take dozens of years of steady labor by old-fashioned methods, where the plow turned a single furrow at once in the "breaking" of the grass-grown sod; in the plowing for the first crop; the harrowing; the sowing by scattering broadcast with the hands from a bag slung from the shoulder; the grain cut with a hand sickle or scythe; bound into sheaves by hand; shocked by hand; thrown into a rack on a wagon by means of a pitch-fork; hauled, stacked, flailed, winnowed, sacked and hauled to market over roads quite unlike those in the better districts of the present day.

The most important of the kinds of machinery which simplifies the work of wheat farming on an extensive scale is perhaps the steam plow.

According to *Popular Mechanics*, the world's record for plowing was broken in a demonstration given at Purdue University, Indiana, in which a gang plow

GASOLINE TRACTOR PULLING PLOWS, PEG-TOOTH HARROW AND LAND ROLLER.
(Courtesy of International Harvester Co.)

having fifty plows and drawn by three traction engines, turned over a stubble field at the rate of an acre every four and a quarter minutes. This mammoth plow cuts a strip nearly sixty feet wide, and turns over seven acres for every mile it travels. Each of the fifty plows is independent of the others, rising and falling as easily and naturally as a wooden chip on the surface of rough water, so that the service of the machine is not confined to ground absolutely level.

What such a plow as the one shown can accomplish when started out on an open, fairly level prairie is remarkable. Allowing for no delays, it will turn over seven acres for every mile traveled, fourteen acres every hour, and, working twelve hours per day, six days per week, it will plow one thousand acres. Working two shifts of men and plowing all night, as is now often done, the acreage turned over in a week would be just doubled. Fifty years ago a farmer with his team of oxen had to toil from dawn to sunset to break an acre of land, walking more than ten miles to the acre.

Disc harrows have succeeded the old time "drag" or harrow.

The drill plow is a plow which both prepares the earth to receive the seed and plants the seed as well. The drill plow carries a great box of wheat, having holes in the bottom which open into tubes which extend to the ground. Through these the grain is let out just as fast as it is needed, and no faster. Behind these tubes are fastened small plows which cover the grain as fast as it is planted.

There are also machines the great engines of which draw the plows, behind them the harrows, and still farther in the rear are the drill plows or earth pulverizers called rollers. While these machines are very costly, they do the work of scores of men and horses, and do it rapidly, tirelessly and accurately.

Reapers which cut the wheat, thresh and sack it ready to be taken to the grain elevators, are now in use on a few of the large wheat farms.

On the smaller farms the reapers which cut, bind, and drop the sheaves in rows are considered a sufficient saving in labor.

In an excellent article on the "Natural Resources of the United States," Mr. G. B. Coffman says:

"Wheat is grown in forty-two States of the Union. In the Eastern and Central States it is grown on small farms. Almost all the farmers in these States grow some wheat. They grow enough for their own bread, and many raise enough to bring in money to supply them with other necessities of life which cannot be produced on their farm. Wheat is raised on a large scale in Minnesota, the Dakotas and California. Many large farms are found in these States. Here the soil is so good for wheat that many farmers raise nothing else.

"For some years the wheat acreage of the United States has been moving westward. As the country has been settled in the Northwest, more and more ground has been found available for the raising of wheat. The acreage has been increasing with the

population. In the last forty years, the wheat acreage has increased threefold. This acreage is perhaps more than the increase of population. In 1866, there were fifteen and a half millions of acres planted in wheat; in 1906 there were forty-seven and a half millions of acres planted in wheat. During these forty years one-third of the wheat raised was exported to foreign countries, most of it going to Europe. At the present time we are not sending away as much as one-fifth of the wheat we are raising. We are using more for bread. At this rate it is estimated that in twenty-five years we shall be importing wheat. If we keep pace with the population and the demands for wheat, we will have to find a way to use the land which is idle now in many parts of the United States.

"There is much unoccupied land in the United States available for the production of wheat. The vast stretch of land between the Mississippi River and the Rocky Mountains no doubt in the future will raise much more wheat than is found growing there now. The knowledge of dry-land farming will cause much more wheat to be raised in the arid region. The rapid advance in irrigation will increase the wheat acreage. It is said that the artificial irrigation in the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah and Wyoming will add to the wheat acreage more than two hundred and fifty millions of acres. The drainage of the swamp lands no doubt will add many acres.

"The annual wheat crop of the United States is upward of seven hundred millions of bushels. Some of this is shipped abroad to be manufactured. A great deal of it is manufactured near where it is raised. This saves freight bills. The chief grain-growing and flour-milling States are Minnesota, Illinois, Missouri, Wisconsin, Ohio, New York, Indiana, Michigan, Kansas, Pennsylvania and Iowa. Many mills of small capacity are yet found dotted all over these States, but larger mills are getting the wheat and the smaller mills are dropping out. This is largely because the larger mills can make better flour and make it cheaper.

"The value of our wheat crop is upwards of five hundred millions of dollars. The capacity of our mills is over a million barrels, and their value three hundred millions of dollars. Since the steel rolls have been substituted for the burrs or millstones we are leading the world in the manufacture of flour, both in quantity and quality. American flour is sought after in all the foreign markets. It is regarded as the standard of excellence by the consumer of wheat bread. There are two reasons for this. One is the improved methods by which it is manufactured, and the other is the superior quality of the wheat of which it is made. If the consumer cannot get American flour, the next best thing is to get flour made from American wheat.

"Not much flour is exported, because it is cheaper to export the wheat and manufacture the flour abroad.

Labor is cheaper in the Old Country, and then the wheat is easier handled than the flour. The freight rates are cheaper for the wheat. If the flour is shipped it must go in sacks and bags and must be carried by men. It cannot be loaded by machinery as wheat can. The wheat can be loaded in the ships by gravitation, that is, by letting it run from the elevator to the ship. Then it can be lifted out of the ship by means of machinery.

"Minneapolis is one of the great centers for the manufacturing of flour. Here are found many mills at work the year round. Flour is shipped from this city to all points of the world. Many men are employed to make the mills go. On this account many other manufacturing establishments have been located, to supply the demands of the men who are engaged in the manufacture of flour. And so we see that one establishment calls for another, and another for another. Thus a civilization is established, and in this way the Great Northwest has been developed and settled.

"Minneapolis commenced to grind wheat about fifty years ago, and it now grinds more wheat than any other city in the world. It has one mill that grinds fourteen thousand barrels every day. There are five mills at Minneapolis which grind five millions of barrels every year. There are other large mills at work night and day. The average person eats one barrel of flour a year, so we can see that Minneapolis feeds many.

PANORAMA OF FAMOUS MILLING DISTRICT. MINNEAPOLIS, MINN.

"There are other great milling centers in this country. Much wheat is manufactured into flour at New York, St. Louis, Chicago, Milwaukee, Kansas City, Toledo, Indianapolis, Superior and Duluth. There are many other places where mills are located. There are about fourteen thousand mills in this country.

"The smaller mills scattered over the country, most of them, grind not only wheat, but corn, oats, rye and buckwheat. Much of this grinding is to furnish food for stock, and the grain is supplied by the farmers living in that immediate country. Grist milling, as this is called, is a great industry. However, not much flour is made in such mills any more. It can be made so much better in the larger mills. There are now about twenty-five thousand of such flour and grist mills in the United States.

"The wheat is hauled by teams from the wheat fields to elevators at the railroad stations, or the wharfs at the water. It is loaded there and shipped in every direction. In the Mississippi Valley, it goes by rail to Minneapolis, or it is put in barges and floated down the Mississippi to St. Louis or the Gulf of Mexico, thence to South America or Europe. Trains are moving toward the head of Lake Superior, where the wheat will be placed in ships and carried through the waters of the Great Lakes, through the Erie Canal to New York, and from there to the Old Country; or perhaps some of it is taken through the Welland Canal to Lake Ontario by way of the St. Lawrence River to the

Atlantic Ocean. Some of it is shipped direct by rail to Chicago, and there ground into flour or placed in ships and sent to the Atlantic Coast.

"Most of the spring wheat is sent to Chicago and there made into flour. This spring wheat is raised north of the southern boundary of Minnesota. This wheat is not shipped abroad because it is not as good a wheat as the winter wheat. Our winter wheat is the best raised in the world and it has a good market in all places.

"The principal markets on the Pacific Coast are San Francisco, Portland, and the cities on Puget Sound. From these ports a great deal goes to supply the home demand and the rest is sent to China, Japan, Siberia, and the islands in the Pacific Ocean. The Hawaiian Islands are supplied from these ports and some of this wheat reaches the Philippine Islands by way of Hong Kong.

"The cost of transportation of our wheat to foreign lands is not so great as we might think. On account of the way we have of handling the grain by machinery, the cost of a bushel of wheat from Chicago to New York by rail is about five cents and from New York to Liverpool, in ordinary times, about two cents. This makes the transportation so cheap that we can compete with the foreign countries in the markets. If the wheat can be taken all the way by water, the cost will not be so much. This is the reason so much of the wheat is shipped to Duluth or the nearest port on the Great Lakes and there placed in ships."

Let us follow a carload of wheat from the Red River Valley, where the finest northern wheat is grown, to the great Washburn-Crosby Mills where more than one hundred thousand bushels of grain may be consumed in one day.

The cars run on tracks up to the doors of the immense receiving elevator, where big power shovels scoop the grain up and drop it into a scale hopper from whence it goes to the concrete tanks, later to be elevated and passed through the various processes which fit it for reduction to flour.

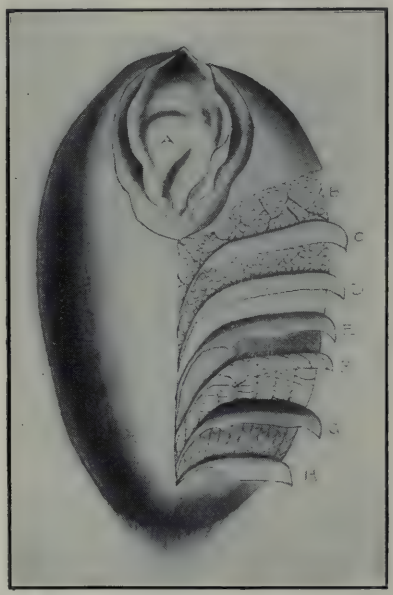
Weeds of many sorts have grown luxuriantly with the wheat and their seeds are mingled with the grain. To grind these with the wheat would change both the color and flavor of our wheaten bread.

The first task then is to separate the tare seeds and to clean the wheat. We shall use the old, familiar process of sifting and aeration. Many siftings and shakings will rid the wheat of all seeds smaller than itself. Drafts of air applied at different points and in varying directions blow away the chaff, bits of straw and the light-winged seeds, and a special process of separation takes out the troublesome cockle seed.

The machine for removing the cockle consists of an inclined metallic cylinder on the inside of which are small indentations just the size and form of the cockle seed. Running through the center of the cylinder is a stationary apron. The wheat to be purified is fed into the revolving cylinder, the cockle falls into the

indentations, is carried round with the cylinder until it gets above the apron when it falls by its own weight, is caught by the apron and separated from the wheat.

The wheat grains are then *scoured* clean and bright in a rapidly whirling cylinder, *brushed* still more furi-



DISSECTED WHEAT KERNEL, MAGNIFIED
(Courtesy Washburn-Crosby Co., Minneapolis)

A Germ, B Gluten cells predominate, C Starch cells predominate, D Interior coat of bran, E Testa, coloring matter of bran, F Endocarp, G Epicarp, H Epidermis

ously, moistened and washed, that the coats of bran may not be too easily powdered, but may be separated in flakes.

Let us examine now our grain of wheat. Under a powerful microscope we find its golden brown bran

coats are five in number, which when analyzed show valuable cattle food properties and a small percentage of woody fibre. At one end we find it still shows a stiff bunch of bristling hairy fibres, its invisible *beard*, for to the eye it is clear and smooth. Within these bran coats there is a hard shell of glutinous matter yellow and half transparent, and of flinty hardness.

UNLOADING FLOUR BARRELS
(Courtesy Washburn-Crosby Co., Minneapolis)

Inside this shell of gluten and merging therewith are starch cells, white as snow, resting within a net-work of the woody fibre. Here we find the germ—small, yellow as brown sugar, and both oily and sweet to the taste.

The process of milling is to remove the bran coats, separate the germ and crush gluten and starch to a powder of velvety softness.

From the top stories of the mill, where the cleansing processes have been perfected, the wheat, measured

by the most perfect automatic device, which by the simple principle of gravity separates from the flowing stream of grain just enough for a barrel of flour (about five bushels), drops to the first floor of the mill where the rollers begin their work of crushing.

The early reductions serve to crush the grain slightly, remove much of the bran and bring the remainder, after several crushings, to the *granular* stage. At each reduction some starch cells are crushed and some flour produced, none of which is allowed to escape with the less valuable bran, but is bolted out and reserved for the various grades of flour. Yards of costly silk bolting cloth are used to separate this fine flour.

Over and over the granular part is crushed and re-crushed and the fine flour sifted out. Over and over the "middlings," as the sifted product of the rollers is called, are purified by siftings and aeration. At one period the germ, which, being easily flaked and not so readily pulverized, is removed before the product reaches the flour stage. If ground with flour the germ would injure the color and affect its keeping qualities.

Finally, as a last precaution and in addition to all previous processes, the flour is again sifted through finest silk bolting cloth.

In these various reductions about seventy per cent of the grain is saved for food, and thirty per cent becomes bran and shorts.

The fine flour is at last dropped into a vertical chute and fills bags slipped over the cylinder of the packing

machine at its lower end. The larger sacks are deftly secured by a few hand stitches across the top and at the ends, while the smaller sizes, which have of late become popular with housekeepers in large cities, are sewed by an automatic machine equipped with needle and twine very much as our home sewing machine is fitted with needle and thread.

The United States raises about one-fifth of the wheat in the world. Europe raises twice as much as we raise. The most of this is raised in the black plains of central and southern Russia and the plains that slope to the Baltic and North Seas.

Asia raises about one-half as much wheat as the United States. The chief fields are found in India and Asiatic Russia. China raises some wheat. Southern Siberia is adapted to the culture of wheat, but at this time but little is raised there.

In Africa some excellent hard wheat is grown in Algeria. Southern Africa produces some wheat. Australia and New Zealand produce some excellent wheat.

In South America, Argentine Republic, Chile, Uruguay and southern Brazil produce wheat. At the present time the fields are near the eastern coast or near the rivers. This gives them access to the markets. There is no doubt that South America will some day be one of the great wheat countries. When the country develops and railroads are built so that the produce can be marketed, South America will take her place with the other wheat countries.

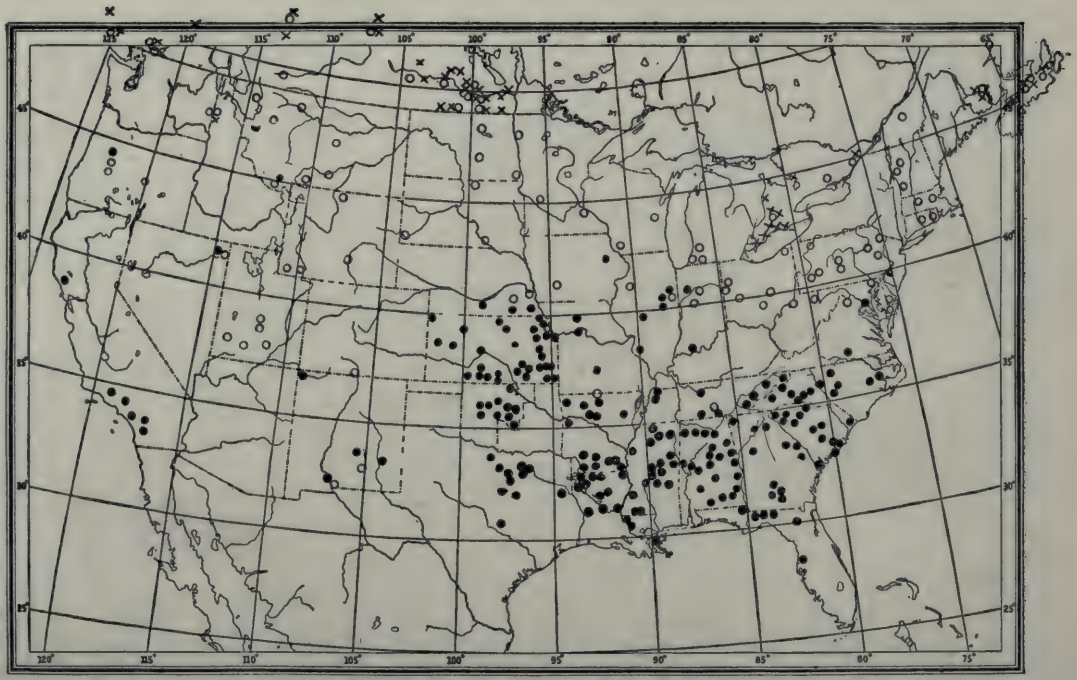


FIG. 3.—Map showing distribution of three varieties of Oats. Cross (×) = Black Tartarian. Spot (●) = Red-Rust Proof. Circle (○) = Welcome.

Canada is also a rival of the United States in wheat growing. There is a vast stretch of land extending from the Great Lakes to the Rocky Mountains that is adapted to wheat culture. Already vast fields have been planted there, and the price of land has rapidly advanced. Canada ranks fifth in the world's production of wheat, producing in 1915 over three hundred million bushels.

OATS AND BARLEY

Oats and barley come next in the value of our cereal crop. The estimated crop of oats for 1915 was over 1,500,000,000 bushels, and of barley 260,000,000 bushels.

The botanical name of the common oat is *Avena Sativa.*

It is extensively grown in all the Northern States, and in New England its production exceeds that of wheat. The varieties cultivated may be divided into two general classes, and these into seven minor groups with individual peculiarities as follows:

GROUPS AND VARIETIES

(*a*) OPEN PANICLE OATS

Long, yellowish-white seed

(1) American Banner
(2) Lincoln

Short, yellowish-white seed

(3) Welcome

Long, brownish or dun-colored seed

(4) Burt
(5) Red Rust Proof

(*b*) CLOSED PANICLE OATS

Yellowish white seed

(6) White Russian

Brownish or black seed

(7) Black Tartarian

MEADOW GRASSES

Besides these grasses from which bread is made, there are also some kinds called meadow grasses, which when dried are called hay, and are fed to horses and cows. Fig. 1 shows us one of our most cultivated varieties, called *timothy*, from Timothy Hanson, who carried the seed from New York to the Carolinas about 1720. It is also called *herd's grass*.

Then, there is the *red-top* (Fig. 2), so called because of its dark red, or purplish color; and the sweet-scented *vernal* (Fig. 3), which blossoms very early, and has a delightfully sweet odor. The baskets made by the Indian women often have the same

fragrance. These meadow grasses are invaluable to man as food for his domestic animals. They are almost as valuable as the cereals upon which man so largely lives.

Fig. 1.

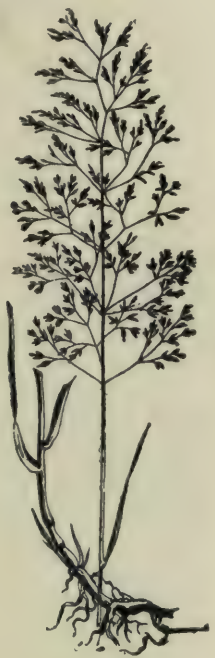


Fig. 2,

Fig. 3.

Grasses are also useful in making our homes beautiful. The poorest, plainest house becomes pleasing to the eye if surrounded by a well-kept grass-plot.

Other useful members of the grass family are the sugar-cane and the bamboo.

TILLING THE SOIL — THE MOST COMMON, AND THE MOST IMPORTANT OPERATION ON THE FARM

LOADING SUGAR CANE ON RAILROAD TRUCKS

SUGAR

SUGAR is obtained from three sources: the sugar-cane, the sugar-beet, and, in a comparatively imited degree, the sugar maple.

CANE SUGAR

Among the many species of grass contributing to the welfare of mankind, not the least is the sugar cane. Of this grass we make use of its juice instead of its seed. The sugar-cane is a very tall, strong grass, its canes reaching to a height of from eight to fifteen feet, and attaining a diameter of one and one half to two inches. The stalk is "jointed" in much the same way as Indian Corn. The joints are filled with a loose,

spongy matter, saturated with a juice which is at first watery, but afterwards becomes sweet and glutinous.

CUTTING THE SUGAR CANE

The plant was originally a native of India. From there it was introduced in the Middle Ages into Persia and Arabia. Under the Arabs the growth and manu-

facture of the cane spread far and wide from India to Morocco, and finally to Sicily and Andalusia in Spain.

In the age of discovery, the Spaniards became in their turn the introducers of sugar cultivation. It was carried to San Domingo in 1494; and it spread over the occupied portions of the West Indies and South America early in the sixteenth century.

The sugar cane requires a rich, well-drained, but moist soil. It is propagated by slips taken from the upper part of the canes, which are planted at intervals of about five feet apart. When mature the canes are cut down close to the ground, the remaining leaves and upper shoots removed, and the stalks immediately taken to a mill for crushing.

The yield of canes varies within wide limits, but twenty tons per acre may be regarded as a good average crop.

When cane sugar was practically without a rival in the sugar world, the cultivation was highly profitable, but it was conducted under tropical skies, largely by slave labor, and entirely removed from scientific supervision.

It was not till the pressure of the competition with beet sugar began to make itself felt that planters realized the necessity for improving their methods of cooking. It has now been found possible to apply many of the improved processes used in connection with the production of beet sugar to the better extraction of cane sugar.

AN IRRIGATED BEET FIELD

CATERPILLAR ENGINE WITH PLOW AND HARROW PREPARING GROUND FOR THE SOWING OF BEETS

BEET SUGAR

The manufacture of beet-root sugar has been carried on in France, Germany, and other European countries since the early part of the nineteenth century. In the United States the first successful experiments were made at Alvarado in California, and it is now a thriving industry in many of our Western States.

In fact, the beet-sugar industry is rapidly assuming great importance in this country. No manufacturing

industry, according to Mr. Charles F. Saylor, in a late report to the Secretary of Agriculture, so intimately associated with and dependent upon agriculture has ever shown such wonderful development, such far-reaching influence in the stimulation and upbuilding of the whole system of agriculture.

PLANTING SUGAR BEETS — SOWING THE SEED

It has done much to improve agriculture, both in Europe and in this country. In Europe the production of sugar beets has been helpful to rotation of crops, fertilization, and improvement of lands. There are large areas known as the sugar districts. Of course these do not comprise the entire agricultural lands of any of the countries. The parts where sugar beets are grown, however, cover a considerable portion of country throughout each of them. Here the beet crop

is recognized as the principal one, and the plans of the farmers are based upon the successful production of beets. Their work is superior to ours, especially in methods of tilth, rotation, and fertilization. As the farms are very much smaller and the population is denser than ours, it becomes necessary that the land

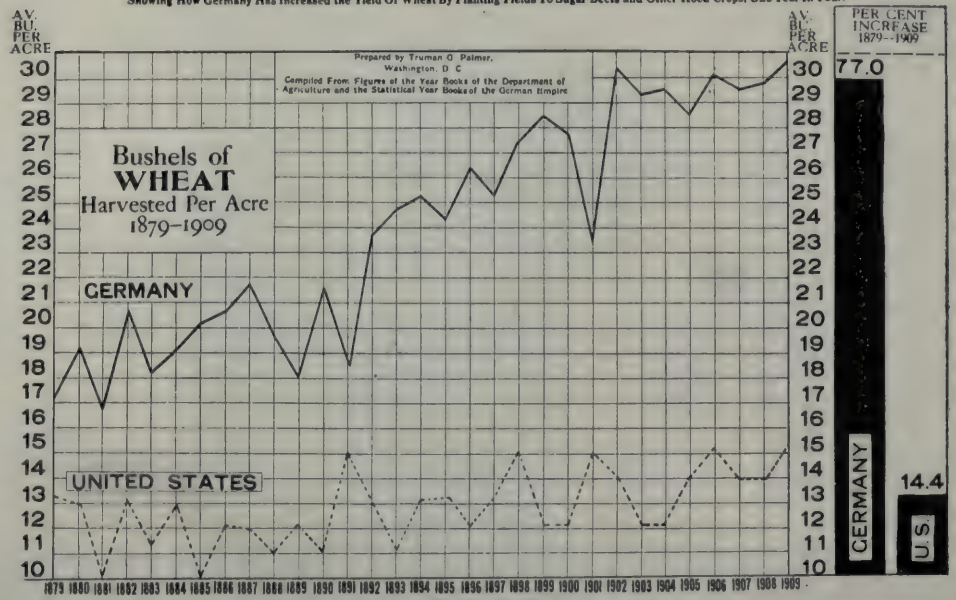
TWENTY THOUSAND TONS OF SUGAR BEETS PILED UP IN FRONT OF A COLORADO FACTORY

be brought to its highest productive power to sustain the population. It is much easier to succeed with intensive farming on small tracts.

The supply of labor is always an important factor in sugar-beet growing. In the European sugar-beet dis-

Agricultural Progress in the United States and Germany.

Showing How Germany Has Increased the Yield Of Wheat By Planting Fields To Sugar Beets and Other Hoed Crops, One Year In Four.

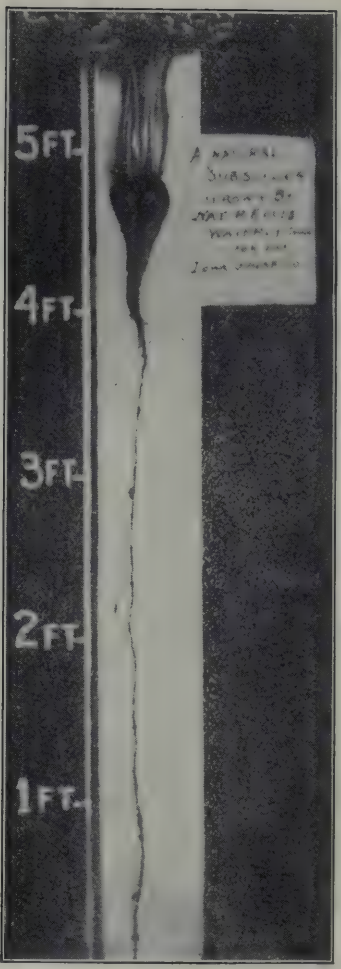

AV. BU. PER ACRE
Prepared by Truman O. Palmer, Washington, D. C.
Compiled From Figures of the Year Books of the Department of Agriculture and the Statistical Year Books of the German Empire
Bushels of WHEAT Harvested Per Acre 1879–1909
GERMANY
UNITED STATES
PER CENT INCREASE 1879--1909
77.0
14.4
GERMANY
U.S.
30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10
1879 1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903 1904 1905 1906 1907 1908 1909

Wheat harvest in 1909.

United States..... 46,723,000 acres (737,189,000 bushels)
Germany ..... 4,523,516 acres (138,000,000 bushels)

tricts there is nothing to hamper production of this principal crop. The people are essentially rural and industrious. There is nothing transient in their plans and aspirations. They are small farmers and hard-working ones. As a rule they are not turned aside by the glitter of city life, opportunities of trade, and other general business activities. They have not the progressive, restless spirit of our people. It is quite common for an American to wind up a successful career at the top, who may have started at the bottom, and followed many a path in the humbler walks of life as a farmer, teacher, merchant, manufacturer, politician, and speculator. Our system may be commended for the opportunities it offers the individual, but not for the advantages it brings to our farmers in the maintenance of a competent labor supply. With their small farms, supply of labor, and habits of settled industry, the farmers of Europe may be said to possess an advantage favorable to sugar-beet production.

Our system will never be the same as those of France and Germany, but a study of their methods should nevertheless prove helpful to us. In this country we need to give more attention to cultivation, rotation, and fertilization, not only in the growing of sugar beets, but in all agricultural operations. Through the occupation of the virgin soils of a new continent we have accomplished much with little effort. Vast areas of cheap lands have been opened up as the tide of immigration has flowed from east to west. Corn, wheat,



A SUGAR BEET

Showing the long tap-root and laterals by which it opens up new depths of fertility and improves the quality of the land.

oats, tobacco, flax, and root crops have been planted without much regard to system, rotation, or fertilization. The virgin fertility of our soil has filled the granaries of our farmers. Their stock has been turned loose on the prairies, to be grazed without care or expense. Our farmers have become prosperous without knowing how or why.

But the public lands suitable to this kind of treatment have passed away. They have been cut up into farms. However patriotic it may be to proclaim the importance and development of agriculture in this country, it must be said that we are in our agricultural infancy. We are just beginning to see the dawn of future conditions and possibilities.

The average yield of beets in Germany is a little over thirteen tons per acre; in the rest of Europe a little less. In this country the average yield is nearly ten tons. Some of our older factory districts secure an average yield of beets equal to that of Germany. Let us compare our present yield with the ideal yield. The most usual width between rows in beet fields is eighteen inches and the beets are eight inches apart in the rows. The ideal size of beet is two pounds. Beets are often much smaller or larger than this. Often beets are delivered to the factory which weigh only half a pound, and sometimes beets are delivered and worked which weigh five pounds; but the ideal is two pounds. In the case of the ideal acre of beets with rows eighteen inches apart and beets eight inches

apart in the row, with a complete stand and every beet growing to a size of two pounds, an acre will yield 43.3 tons. While it is improbable that this ideal acre of sugar beets will ever be produced, on account of the improbability of having a perfect stand, it seems possible that this tonnage can be produced, because the

PILED BEETS, SCOTTSBLUFF BEET DUMP, SCOTTSBLUFF, NEBRASKA

beets may be sufficient in size or weight to compensate for the shortage in numbers.

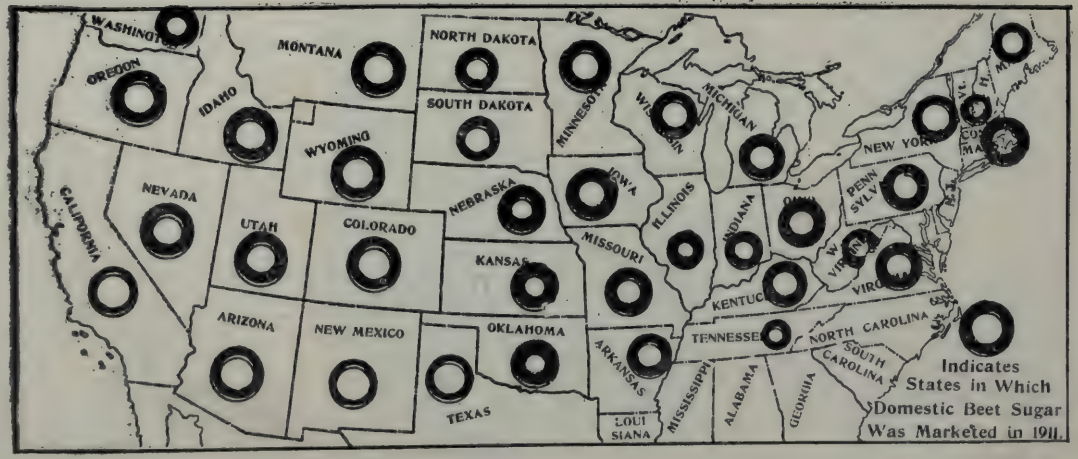
There is a vast difference between the present actual average tonnage and this ideal or possible yield. The difference is more than thirty-three tons per acre. This difference of thirty-three tons between actual and ideal constitutes the farmer's leeway for improvement. That he can increase his actual yield to overcome a

considerable part of this difference goes without saying. The more he reduces it the more will he have performed his part.

In the markets of the world there has been a constant rivalry between the producers of sugar from cane and from beets. This contest has been vigorous and prolonged. It has been a strife for commercial supremacy between the luxuriant conditions of growth and semi-civilized poorly paid labor of the Tropics on the one side and the highly developed agricultural lands and high-priced labor of the central temperate zone on the other. It is largely a contest between intelligence and ignorance, the latter reinforced with especially favorable neutral conditions.

The progress of methods on the farm and in the factory in the past has considerably more than doubled the amount of sugar produced on an acre of land. It appears possible through further development along these lines to double the present results in the United States, thus greatly reducing the cost of producing sugar.

Work on the farm from the beginning of the industry has been largely a matter of hand labor, laborious and expensive. In Europe to-day most of the cultivation in the fields consists in hand hoeing. Farmers there are slow about changing their methods or devising new ones. With its introduction into the United States a revolution in farm implements in the beet field is rapidly taking place. We have introduced less cumber-


WASHINGTON
OREGON
IDAHO
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
WYOMING
NEBRASKA
NEVADA
UTAH
COLORADO
CALIFORNIA
KANSAS
ARIZONA
NEW MEXICO
OKLAHOMA
TEXAS
MISSOURI
IOWA
ILLINOIS
MICHIGAN
INDIANA
KENTUCKY
TENNESSEE
ARKANSAS
MISSISSIPPI
ALABAMA
GEORGIA
NORTH CAROLINA
SOUTH CAROLINA
NEW YORK
PENNSYLV
Indicates States in Which Domestic Beet Sugar Was Marketed in 1911.

some and more effective implements for seeding and horse cultivation; we also make more use of the harrow and the roller.

When the industry came to us we adopted the system of harvesting then in vogue, using a plow to cut off the beets and to loosen the beets by the aid of lifting prongs

RECEIVING BEETS AT THE BRUSH FACTORY

or a share. The rest of the work was done by hand. Beets were "topped" by a person passing along the row, lifting the beet from the soil, and clipping off the crown and leaves with a long knife. They were thrown into piles and then into the wagon for delivery to the factory. Considerable study has been given to improving this method. Harvesters have been devised for lifting the beets, topping them, removing the

larger portion of the dirt, and elevating them into a wagon for delivery to the factory. These machines are not now in general use, but their use is increasing. Different devices of this kind have proven their efficiency. It is apparent that they will be more generally used in the near future. It costs from six dollars to eight dollars an acre to harvest and deliver beets five or six miles. One of the principal items of cost is this

DELIVERING BEETS, BETTERAVIA, CALIFORNIA

old hand method of harvesting. Under this new system the cost would be materially reduced.

Steam and electric power are coming actively into use in the sugar-factory districts. An ordinary beet wagon, propelled by four or six horses, will deliver to the factory over ordinary roads from four to five tons of beets. In a number of places traction engines are brought into use, very much reducing the cost of delivery. A train is made up of a number of loaded beet wagons and hauled by one of these engines to the factory.

Traction engines are now more commonly used for plowing up the land. Gang plows are used and in some instances they turn over as much as fifty acres per day. It appears probable that eventually traction engines will be used extensively to propel beet harvesters.

Great improvement has been made in the sugar factories themselves. New devices have been introduced to shorten the process and conserve energy. Modern factories are now built fireproof of the best material — stone, brick, cement, and steel.

A larger use of the by-products resulting from the beet-sugar industry is one of its principal hopes. We are in our infancy also in this regard. Europe has worked out this problem. In Germany, France, and to some extent in Russia and Austria, alcohol is produced extensively from beets and the by-products of the mills. Their factories are equipped with special drying plants where the pulp and sometimes the molasses are utilized in the preparation of stock food.

Only about a dozen factories in this country have installed drying plants. With our great stock-feeding interests we should better appreciate the value of these by-products. Considerable of the pulp produced in this country is still thrown away. Most of the waste lime is treated in the same manner.

It must be evident that in the improvement of methods and appliances used on farms and in factories lie a great opportunity for the future growth of the beet-sugar industry.

MAPLE SUGAR CAMP

MAPLE SUGAR

Nature has another interesting sugar factory, and though not of such vast proportions as the cane and beet sugar industries, it may be more to the taste of young people. I need not say that I refer to the maple sugar tree. Let us now take a trip to one of these Vermont sugar groves.

Of all the varieties of maple trees found in various parts of the world, and they number nearly seventy, Vermont produces seven. These are the sugar maple (sometimes known as the sugar or rock maple), the black maple, the silver maple, the red maple, the mountain maple, and the box-elder or ash-leaved maple. By far the best for sugar making purposes are the sugar maple and the black maple.

The sugar maple is a long-lived tree. It is said that some trees on Vermont hillsides, still used for sugar-making purposes, have been growing since the Pilgrim Fathers landed at Plymouth in 1620. A maple is seldom suitable for tapping before it is forty years old and twice that number of years makes it much more valuable. Although the tree is comparatively slow in its growth, it is easily propagated and is a sturdy tree.

The greater part of the maple sugar of the United

States is made in the six States of Vermont, New York, Ohio, Michigan, Pennsylvania, and New Hampshire, although the last census report showed that maple sugar or syrup was made in thirty different States.

Few maple products are made south of Maryland and Kentucky and west of Missouri, Iowa and Minnesota. The maple sugar area, however, extends northward into the Dominion of Canada and Newfoundland. The sugar maple does not grow naturally in Europe.

Maple sap is composed of water, sugar, mineral ingredients like lime, potash, iron, magnesia, etc., and certain vegetable acids. The moisture in the soil dissolves and holds in solution certain of these mineral elements, and the roots of the tree draw them up, together with a large amount of water, through the living tissues of the tree, this moisture being transpired or breathed out through the leaves, much as living creatures exhale breath from their lungs. Until the moisture passes through the leaves, the sap is termed crude sap.

The sap contains from two to six per cent of sugar, and this sugar forms Nature's food for the growth of the tree. If a healthy maple is tapped in a reasonable manner, according to the best methods, it does not appear to deprive the tree of sufficient nourishment to injure its health or to check its development. Just before the leaves put out, after the roots begin to absorb water in considerable quantities, the tree contains the largest amount of moisture, as it is not able to

throw off any of this moisture through the leaves. It is at this period in the spring when the sap flow is largest.

In order to produce ideal conditions for a good sap flow alternate freezing and thawing are needed, moderately warm days and freezing nights. It is said that a temperature of twenty-five degrees at night and fifty-five degrees during the day, with damp northerly winds, furnish ideal sugar weather.

The periods of sap flow are known as "runs" and they vary in number as the season is good or poor. Most of the sap flows in the daytime, but occasionally it flows at night. The opening of the sugar season comes in Vermont as the winter is breaking and the first signs of spring appear.

Sugar making has begun as early as February 22, and as late as the first week in April. The season lasts on an average about four weeks. The longest run on record included forty-three days, and the season ends when the leaf buds begin to swell. As the sap flow diminishes it becomes thicker and more stringy. This is due to the changing of the sugar in the sap into glucoses for the use of the tree.

History does not record the time or the manner of the discovery of the secret of maple sugar making, because this discovery presumably was made by the American Indians before history began to be written, perhaps many centuries before the white man came. The Indians are known to have made maple sugar

MAPLE SUGAR TIME — LOADING THE SAP

prior to the year 1673. There are legends that tell of the breaking of the root of a maple tree which led to the discovery of the sweetness of the sap, and the catching of the sap, in which venison was boiled.

The Indian method of tapping trees was to make a diagonal incision in the trunk of the maple, perhaps with a tomahawk, into the lower end of which was inserted a reed, or concave piece of bark, through which the sap was conveyed into a bark trough or other receptacle. The Indian method of boiling was to drop hot stones repeatedly into the clay or bark vessels containing the sap. The journals of a prisoner, made captive by the Indians in 1755, relate the fact that the natives stored sap in large troughs made of elm bark, often one hundred gallons capacity.

The early white settlers to a considerable extent followed the Indian methods of sugar making, but substituted wooden spiles or spouts for the reed or bark spouts, and used iron or copper kettles, usually the former, for boiling purposes. It was necessary for the pioneers to produce nearly everything that the family needed for food or clothing, and maple sugar was the only sugar most of them could obtain, white sugar being a luxury beyond the reach of most of the early settlers. There was no market for maple sugar at that time and only enough was produced to satisfy the needs of the producer.

In pioneer days the first requirement was land to cultivate, and forest clearing rather than forest con-

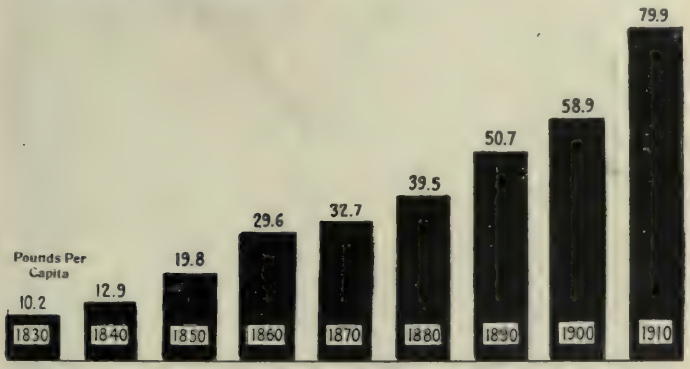
servation was considered a necessity. In following this policy thousands of great sugar maples were burned by the early settlers, not only to clear the land, but also for the reason that from the ashes could be produced a remarkably fine grade of potash salts, which, in many instances, was the only commodity which the pioneer could turn into ready money, most business being conducted by a system of barter.

The primitive methods of sugar making included catching the sap in wooden troughs, boiling it out-of-doors, usually in the useful potash kettles, suspended on a pole between two forked stakes.

Within the past half century notable improvements have been made in the manufacture of maple products. Tin and galvanized iron buckets have replaced wooden ones, and many sugar makers have found that the quality of their product was improved by using covered sap buckets. Metal sap spouts with a hook from which the buckets are suspended take the place of wooden spouts, delivering sap into buckets suspended from a nail driven into the tree, or placed on the ground and propped up by stones. Gathering tanks take the place of an open tub or barrel drawn by horses or oxen, and sometimes pipes convey the sap to the sugar house.

Trees are tapped with a small bit now instead of an auger. It has been found that a small hole bored only a little way into the tree is quite as effective as a larger hole penetrating the tree several inches.

Of the annual world production of sugar about 6,000,000 tons are made from the cane and over 8,000,000 tons from the beet.



CONSUMPTION OF SUGAR IN THE UNITED STATES

Includes all sugar, whether for direct consumption or for manufacturing purposes

In the United States the sugar produced yearly is as follows: 1,000,000 tons of cane sugar (including Hawaii and Porto Rico); 600,000 tons of beet sugar, and about 9,000 tons of maple sugar.

SORTING COFFEE BERRIES

COFFEE

COFFEE

AMONG the world's great industries the preparation and furnishing of beverages for mankind form a very important part.

To-day the United States is the greatest coffee-importing country in the world, and the preparation and marketing of this product gives employment to many people.

The history of the introduction of coffee drinking is very interesting, but we have not space for it here. Africa seems to have been the native country of coffee, and the tree still grows in a wild state in Abys-

sinia in North Africa. It was brought from Abyssinia into Arabia about the beginning of the fifteenth century; and for about two hundred years the entire supply of the world was obtained from Yemen in

South Arabia, where the celebrated Mocha or Mokha is still cultivated.

About 1690, however, the Governor-General of the Dutch East Indies, a very thoughtful and enterprising man, received a few coffee seeds from merchants who traded between the Arabian Gulf and Java. These seeds he planted in a garden, where they grew and flourished so abundantly that the culture, on an extended scale, was immediately commenced in Java.

One of the first coffee plants thus grown was sent to Holland. There it was replanted in the Botanic Garden at Amsterdam.

A few years later the plant was introduced in the West Indian Islands, and thus gradually the culture of coffee extended throughout the New World, till now the offspring of the single plant sent from Java to Holland produces more coffee than is grown by all the other coffee plants in the world. In fact, the cultivation of coffee is now general throughout all civilized regions of the tropical world.

To-day Brazil in South America heads the list of coffee-growing countries; its annual produce probably exceeding that of all other countries combined.

Coffee needs a warm climate in order to develop properly. The seeds are first sown in a nursery, and the young plants, when they are a few inches high, are planted out at distances from each other of from five to six feet. The operation of planting is one which requires great care; and much labor must be expended

DRYING THE COFFEE BERRIES

on drainage, weeding and cleaning the plantation, and in pruning or "handling" the plants.

The plants begin bearing in their second year, and by the third year they should yield a good crop. The leaves of the coffee tree are evergreen, and the flowers are white. When the berry is ripe it is red, resembling a great cherry, with two hard seeds in it. As soon as the outer pulp begins to shrivel the berry is ready for picking.

After the berries are gathered by the natives into big baskets, they are taken into a great warehouse. Here they are dumped into a big machine, having two roughened cylinders, which strips the outer pulp off, leaving only a thin skin husk covering the seeds. The seeds are then spread out in the sun to dry. When dry enough they are again passed through a machine with heavy wooden rollers, which breaks and carries away the dried husk coverings.

The shelled coffee is then graduated into different sizes by passing down a tube perforated with holes of regularly increasing size. The various sizes are next hand picked to free them from defective seeds, and the coffee is now ready to export. Swift steamers bring it to New York, Boston and other Atlantic Coast ports.

As the green coffee arrives from the steamship in its original bags it is taken by elevators up to the top floor of the factory. The picture, page 175, shows a corner of one of these great receiving lofts. Every care

PICKING COFFEE BERRIES

is now taken to keep the product clean and such is the invention of man that from the time the coffee comes from the ship until it reaches the retailer or consumer, no human hand touches it.

The first process in the preparation of the coffee is

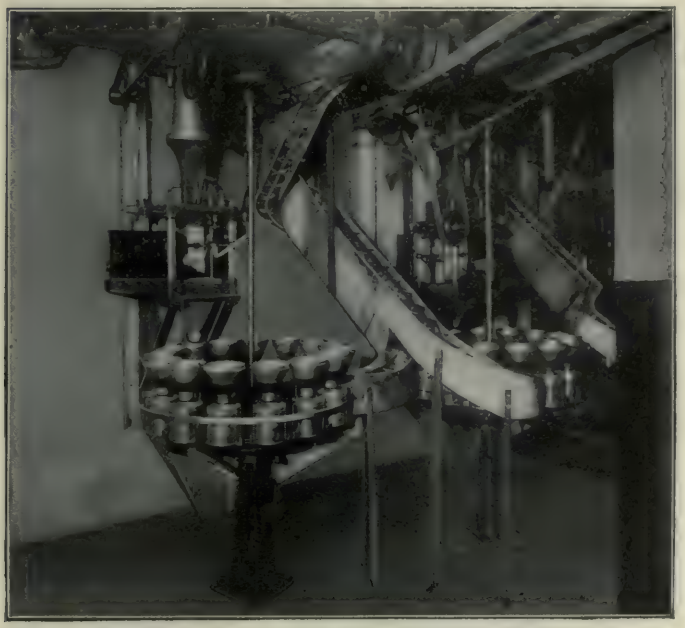
HOPPERS LEADING TO ROASTERS
Courtesy Chase & Sanborn, Boston

that of screening. The green coffee berries are emptied from the original bag into a machine in which is a series of screens, of various meshes, moving back and forth. The berries drop from screen to screen, according to size, and are thus again sorted. Imperfect

LOADING COFFEE AT SANTOS, BRAZIL

berries, or those from which the hulls have not been entirely removed, are also automatically eliminated.

The coffee next goes to the "hoppers," and after being "blended" and weighed, drops directly through the sliding bottoms of the hoppers into roasting ovens



WEIGHING MACHINES WITH REVOLVING TABLES
Courtesy Chase & Sanborn, Boston

on the floor below. This process of "blending" the green berries is of the greatest importance, requiring a precise knowledge of the proportion of each kind of berry, to meet various preferences of coffee drinkers.

Next comes the interesting process of roasting, re-

SCENE ON A COFFEE PLANTATION

quiring long experience, exact calculation, and a feeling for perfection. When the berries, after revolving in the great roasters, are of exactly the right color, they are taken from the ovens into large, shallow, pan-like trucks, and by means of a suction draught pipe, cooled quickly. Each roasting oven can accommodate five hundred pounds of green berries at a time.

Now the coffee receives another screening and brushing, which finally guarantees the exclusion of imperfect berries and every particle of dust. Such coffee as is to be ground, coarse or fine, then goes through large grinding mills, but only a small portion of the coffee is ground in the factory. Many people like to grind their own coffee, so the larger part of it, in the berry, is stored in huge bins, to be packed later in large cans for the retail grocers.

That part of the coffee which is to go into smaller cans is automatically weighed and packed by an ingenious machine as shown in the illustration. The only hand work required is in putting the cover on the can. A human weigher might make an error in weights sometimes — this little machine never does.

Next the labels are affixed to the cans by a clever machine having a capacity of sixty per minute. After the covers are put on, the cans roll through the machine and come out nicely labeled and ready for shipping.

Meanwhile other grades of coffee are being put up in paper bags. The weighing is automatic — only the tying is done by hand.

THE CACAO TREE, PODS ON THE TREE AND IN SECTIONS, AND THE BLOSSOM

COCOA

COCOA, or more properly cacao, is another valuable beverage of mankind; and every year is being used more and more in the United States.

Cocoa, by some people, was apt to be confounded with coca, the plant of Peru which the Indians used to sustain them in their weary journeys across the mountains, and which furnishes the drug (alkaloid) called cocaine in medicine; but cocaine and cocoa are from entirely different plants, and have nothing in

common. Cocoa is supposed, also, by some people, to be of the same family as the cocoanut; but here, too, the resemblance goes no further than the name, for the cocoanut is a palm and requires an altogether different soil for its growth from the cocoa tree.

Its Aztec name, *chocolatl*, shows that the plant is distinctly American.

The produce of the cacao tree, gathered principally in June and December, is commonly known as the "pod." It varies from ten to twenty ounces and comprises from twenty-five to forty beans in five divisions surrounded with a red pulp of an agreeable acid flavor. When plucked the pods are gathered into a heap under sheds and left there for three days. They are then emptied, and the seeds are separated. It is these seeds (or beans) which constitute the edible part of the fruit — the cocoa. They are shaped like two almonds, gently flattened, the one entering the other, separated by a slight skin and inclosed in a husk covered with long fibre. This husk is of a dark color, although the bean is a clear brown, and sometimes violet or black. The beans, still surrounded with pulp, are dried in the sun and then heaped together to undergo fermentation, which is of great importance to their future quality.

The Cocoa Legend. According to the Mexican legend, Quetzlcotl, the divine cultivator, brought from Paradise — where lived the first children of the sun — the seeds of the quacaholt, the tree of trees, and an

object of veneration to the people whom it furnished with a food that was considered of celestial origin. It is thus that the grateful fancy of all nations has derived from Paradise the fruits that are the basis of their subsistence. From the highest antiquity the Mexicans regarded the cocoa bean as a providential

DRYING COCOA BEANS IN THE SUN

food, attributing to it the most marvelous properties. They even used it as current money; the kountel equaling 400, the xiquipil 80,000, and the karga 240,000. The city of Tabesco paid Montezuma an annual tribute of 2000 xiquipils.

The Mexicans roasted the cocoa bean, and con-

sumed it in the form of soup, with a mixture of maize flour and a seasoning of red pepper.

The Spaniards, after the conquest of Mexico, having appreciated the remarkable qualities of cocoa, kept it entirely for their own use, and rigorously prohibited its exportation. About two centuries ago, however, cocoa crept into the court of Louis XIV.

Chaliou first established a cocoa shop in Paris, at the junction of the rue St. Honore and the rue de l'Arbre Sec, a spot which is now occupied by a fountain. The faculty of medicine soon favored the new product.

Chocolate houses appeared about the same time in London and became common a generation later, in the time of Addison and the Spectator. From Spain, early in the seventeenth century, the use of chocolate passed into Italy, being extended there by Antonio Carletti, of Florence, who lived a long while at the Antilles.

The demand for this article has steadily increased since then in every civilized country. There are many manufacturers of chocolate and cocoa in various parts of the world, but the development of this industry is chiefly due to the enterprise of two European firms — Menier in France and Van Houten in Holland.

Up to sixty years ago the demand for the article was limited and the price was prohibitive. Its sale was restricted to apothecaries and confectioners, who sold it in the form of bonbons and sweetmeats. The

method of its production was most primitive. The pulverization was done by hand — a process at once slow and repulsive, and the article as offered for consumption was largely adulterated with foreign matter. Things were in this state when cocoa entered upon a new era, thanks to Menier and Van Houten, who, independently of each other, from 1825 to 1828, made a great progress in its manufacture and placed it within the reach of all classes.

M. Menier founded in France an establishment for the manufacture of pharmaceutical products in general, but principally of those which could be reduced to an impalpable powder. It was the first factory in France where mechanical pulverization was conducted on a large scale. The manufacture of chocolate, which was at first an accessory, eventually became the chief branch of the business.

Chocolate is a mixture of cocoa and foreign matters. Each country has its formula of production. Sometimes starch is added; sometimes only sugar and aromatics.

It occurred to M. Van Houten, in Holland, cocoa might be supplied in a form preferable to that of chocolate without the addition of foreign matter. It is to this idea and to M. Van Houten's researches and experiments that we are indebted for the cocoa powder, of which he was the inventor and for the manufacture of which he was granted a patent in 1828. The sales of this new product gradually extended,

but its merits have become widely appreciated only during the last twenty-five years.

Many improvements, however, have been effected during the last thirty or forty years in the machinery for manufacturing cocoa and chocolate. The present method differs greatly from that of former times. Not to speak of the primitive fashions of the Tolteks and Aztecs, which still linger among the Spaniards and Mexicans, history informs us that in the first methods with any pretension to science the cocoa and sugar were mixed by men who worked upon their knees, so that few industries were so arduous or so injurious to health. In 1776, a Frenchman, named Doret, invented a water-power machine by which hand work was entirely superseded. Doret received a recognition from the Government on the proposal of the faculty of medicine at Paris, with permission to call his works the "Fabrique Royale."

Since 1778 all the operations have been performed by machinery except the sorting of the beans and the wrapping up of the cakes. Cocoa and chocolate up to a certain point go through the same process of manufacture.

When the beans arrive at the factory in Holland, France, or the United States, they are blended to get the best smoothness and richness of taste. This is a matter of skill and judgment, and upon the blend depends the character of any particular brand. The beans are next roasted, also a critical process; then

they are crushed and the shells winnowed from the "nibs." These "nibs" or kernels contain the real flavor. They must be ground to the fineness of flour, and at the end of this reduction process they have become a liquid like molasses. This liquid condition is due to the presence in the "nibs" of an oily substance called "cocoa (cacao) butter," and up to this point all products from cacao are practically the same. The difference between chocolate and cocoa, as it is known to the trade, is due to this cacao butter. It is retained in the chocolate, but for cocoa it is squeezed out and thus becomes a commercial product of itself.

If chocolate is wanted, the paste is poured into molds and allowed to harden into cakes, or if sweetened chocolate is to be prepared, sugar and some flavoring, like vanilla, is added before the formation of cakes.

If cocoa is wanted, the "butter" is expressed, the remaining powder again ground, dried thoroughly, and is then ready for canning. Cacao is said to be more digestible than chocolate, the reason being that the cacao butter, although in itself an easily assimilable fat, somewhat retards the digestive process of the latter.

Both preparations have stimulating and nutritive qualities. The nutritive value depends upon the oils and vegetable ingredients of the bean, for the drink is more than a decoction like coffee or tea. It is rather a solution in which all nutritive factors are retained. The stimulant value is due to the alkaloid theobromin,

almost, if not quite, identical with caffein, the active principal of coffee and tea. "Theobromin" is a word formed by analogy from the botanical name of the plant, which is "theobroma cacao" — food for the gods.

Cacao has one feature which at the present may commend it to those seeking a home in the Tropics — its production seems in general to lag behind consumption, or, in other words, popular taste throughout the world is being educated up to chocolate and cocoa faster than the supply increases. This does not necessarily signify that the price of the bean is rising, but in proportion to the demand the production keeps on the favorable side of the market.

DOMESTIC ANIMALS

SCIENCE has some wonderful stories to tell of our farm animals and their relationships. Men who have studied these things say that the pigs, the oxen, and the sheep are all distant relatives. Other members of the same family are hippopotami, camels, deer, giraffes, and goats. All these animals belong to the family of "artiodactyla." The family gets its name from the Greek language, in which the word means "even-toed." That is, they all have an even number of toes, which is the feature in which the scientists find the family resemblance, just as a boy's friends find a family resemblance in his eyes, or his hair, or his nose.

As for the horse, he must be lonely, indeed, because he has no relatives about the farm at all. In fact, the family that the horse belongs to is rather dying

out, for the only animals he can claim any kinship to nowadays are the tapirs and the rhinoceri. The horse's last name is "perissodactylon," or odd-toed.

PLOWING

He started as a little beast, no bigger than a fox, with five toes on each front foot and three toes on each rear foot. Gradually the toes grew one into the other till the horse has just one on each foot, which we call his "hoof."

Of all the many thousand kinds of animals known to science, only about sixty can be truly domestic; and by this is meant animals which can be tamed and bred in captivity, and will live under civilized conditions. While scientists say that the domestic animals of the present are not as intelligent as the wild creatures

which were their ancestors, they also add that man would never have become civilized had it not been for such beasts as the horse, the ox, and the sheep. As an example, the Indians of the plains in the country are mentioned. Originally they were a feeble race, hunting game as best they were able, on foot and with dogs. Then the white man brought the horse into the country, and as soon as the Indian likewise gained mastery of that animal he became a dangerous antagonist to the settler. More than this, he was able to live better, as well as fight better, with the aid of the horse.

We call the age in which we live the age of the machine, the era of steel; but even so, in this, the most advanced country in the world, the amount of power developed by draft animals on the farms of the United States exceeds the amount of power developed by machines in all our factories of every kind. Furthermore, one of the greatest industries in the country — that of meat packing — depends directly upon the farmer's best friends, his domesticated animals. Such is the importance of the creatures you see about you, in barnyard, pasture, fold, and pen.

PLOUGHING WITH OXEN

HOW MAN MADE THE ANIMALS TO HELP HIM

It was not until man learned to provide a home and to care for his family that he showed himself to be superior to the best. When home life began, family ties were strengthened, love for the different members of his family increased, and all the finer attributes began to develop.

Man needed helpers in his struggle with the outside world, and so did the animals of the forest. Man had wisdom and foresight; animals had food and physical strength. Man needed the animals, and they needed man. But before man learned the value of different animals it is quite probable that he used them only for food. The dog was probably used first as a food, but it aided man in capturing other animals,

therefore it gradually ceased to be used as a food, and instead became an important means of securing food. The horse and the camel also were probably used for food at first; but, on account of their superior strength, they became beasts of burden and aided in securing food for man and in fighting man's enemies. The sheep, the goat, and the cow were also domesticated, to be used as a food in time of need. They were of triple value. The milk was a wholesome food, and could be preserved in the form of butter and cheese; their hair or hides could be converted into clothing, and they could be used, like the horse, as a beast of burden. The fowls of the air were likewise domesticated. The hen, the goose, the duck, the turkey, the pigeon, and the peacock gave their eggs for food and their feathers for bedding and even for clothing. Man did not stop here. He went into the forest and caught the wild hog, tamed him, and improved the quality of his flesh until it has become a very important food.

Thus man rose superior to the beast of the forest and the fowls of the air. They contributed to his needs, but he in turn was obliged to provide food for them in order that they might be of more value to him. It was learned that the value of domestic animals is determined by the care that man takes of them. In providing food for them it was discovered that the hard cereals made the best food for himself and his domestic animals, and cereals became, therefore, the chief food of both man and beast.

BROWN BESSIE, PUREBRED JERSEY

Champion butter cow at World's Fair, Chicago, 1893. Record for 90 days 3,634 lbs. milk, 216.64 lbs. butter.

THE COW

Did you ever stop to think how much we are indebted to the cow? People who lived two or three thousand years ago seemed to have had a higher appreciation of the value of this animal than we have. The word "cattle" means wealth, and the English word "chattel," derived from "cattle," is still a reminder to us that we have valuable property in this animal.

It is believed by many that the cow was the first of the wild animals to be domesticated, and that she has contributed more to the development of our civilization than any other animal. In early days she was considered so valuable that a man's wealth was meas-

ured by the number and size of his herds. Abraham was rich in cattle, and before the real beginning of agriculture the chief occupation of man was tending and improving his flock.

So valuable has this animal been to the human race that it was considered sacred by many early races, chief of which were the Egyptians and Hindus. Cattle was the chief medium of exchange by early civilized tribes, and it is said that the first coin of the Greeks had an ox stamped on it. To kill needlessly or mistreat cattle of any kind was considered a crime by the Greeks, Hebrews, Egyptians, and Hindus.

The cow is just as valuable to us as she was to the ancients who held her in such high esteem. She gives us milk, butter, cheese, and her flesh for food, and without it man could hardly live. She gives us her hide for clothing, and without it we should be sorely in need, and we should have to go back to the wooden shoes that very poor people have worn in different ages. She gives us fertilizer for our crops, and if this plant food should be suddenly taken away the farmer's fields would degenerate. She gives us her bones for buttons with which to fasten our clothes. Her hair is used in making furniture and many other useful articles. She not only gives us all these things, but she gives us power to pull our carts and plows; in ancient times this was almost the only power used by some peoples in cultivating their land.

The cow is used for three things — for beef, for milk,

and for butter and cheese. For the past two hundred years, and especially for the past fifty years, man has studied the influence of different kinds of food on the cow and has employed the knowledge gained in breeding animals suited to his several needs. As a result, we have three distinct breeds of cattle — one that gives an abundance of milk, one that gives milk especially rich in butter, and the third, called the beef cow, most of whose food is converted into flesh which we use for beef.

We are indebted more to the British Isles and to Holland for our improved cattle than to any other country. It is said that the Romans, when they conquered Britain, brought cattle to England. The animals of Rome were mixed with the native breed, and from this crossbreeding has come the excellent stock of to-day. The most noted cattle that we have are the following:

The Jersey, brought over in 1818, has attained the widest reputation as a butter producer.

The Holstein, brought by the Dutch when they settled in the present State of New York, is noted for the quantity of milk it produces. It is said that as much as ten gallons of milk a day have been taken from a single cow. Another breed noted especially for milk is the *Guernsey.*

The Shorthorn, imported from England about 1817, is the most widely distributed, and it is especially noted for its beef making. Another kind of beef cattle

is the *Hereford.* These cows give very little milk; in fact, farmers raising them rarely find it worth while to milk them at all. But when these animals are properly cared for, they are fat and plump and almost

IMP. FLORA, PUREBRED AYRSHIRE
Record of 11,532 lbs. milk in 1902; 10,627 lbs. milk in 1903

square. Another one of the family breeds of beef cattle is the *Aberdeen Angus*, or as it is sometimes called, the *Polled Angus.* This breed originated in Scotland and was brought to this country in 1873.

The systematic improvement of cattle by man began about the close of the eighteenth century. The greatest progress was made in Great Britain, and to Robert Bakewell, of Leicestershire, who lived from 1725 to 1795, must be given the credit of producing such superior animals as to entitle him to the distinction of being called the father of modern cattle breeding.

MILK AND BUTTER

COWS are generally milked twice a day; in the morning and evening. They must be kept very clean and always be milked quite dry. If the cows are left too long without milking, they suffer pain, and if they are not well drained every time, they soon begin to give less, until, at last, no more milk will come.

During the process of milking the cows, small particles of hair, wood, and other matters, are apt to get into the milk-pail. The milk has therefore to be strained through sieves into the milk-pan, set away for the cream to rise, or poured into tall tin cans for the milkman.

The matters which constitute milk are: 1 The aroma, or that part of the milk which gives the odor or smell. 2 Water, of which the greatest part of

A DAIRY HERD, IN THE STATE OF WASHINGTON.

the milk consists. 3 Bland oil, from which the cream is formed. 4 Curd, or clot, whch is the same as the gluten in flour, and is the part from which we make

MILK TESTING, COOK COUNTY RURAL SCHOOL

cheese. 5 Sugar. Various salts dissolved in the fluid.

In the course of a day, or a day and a half, the cream, or oily part of the milk, has risen to the top, and is skimmed off with a skimmer. The rising of the cream is due to the fact that it never was dissolved in the milk, as sugar dissolves in tea, or salt in water, but floated about as tiny globules in the liquid, too small to be seen; and when the milk was spread out in the pans and kept perfectly still these globules

took advantage of the chance to push themselves up to the surface. You know that milk can be kept only for a day or two before it "sours." This is because an acid is formed by fermenting and some of the "milk-sugar" has disappeared. Because of this unpleasant habit which milk has of growing sour, scientists studied until they found a way to prepare milk so that it might be kept for a long time. This plan was to remove a greater part of the water contained in the milk and to add sugar. This is now done in factories where the milk is strained, heated by being set in cans into hot water, sweetened with the best sugar, subjected to steam, set into cold water and finally poured into large drawing cans with faucets. These faucets make very easy the work of filling the small tin cans which hold about one pound each, and which are immediately sealed with solder to keep out the air. It is sold under the name of *condensed milk*.

Butter making by churning requires much skill and patience. Cool temperature of both the cream and the air in the dairy is best for churning. In old times it took three or four hours to churn butter and the labor was very hard. But the tall, upright churn, looking something like a firkin with a "dasher" in the middle, has gone out of fashion.

But inventions and improvements have been made, until, now, the churning can be done in a few minutes. To-day much of the butter-making is now done in factories or "creameries."

BEEF IN COLD STORAGE ROOM IN A LARGE PACKING HOUSE

MEATS

BEEF stands at the head of all flesh foods in its power to sustain life. Cattle are the lords among food animals. Every part of the huge bulk of the cow has its admired quality, not approached by other meats.

In Chicago there are establishments where five million head of cattle are slaughtered every year.

In through the gates troop the unsuspecting cattle;

choice "corn-fed" animals from the West and "grass-fed" Texas cattle from their summer rambles.

The part of the yard which they enter is boarded at the sides with plank seven or eight feet high, but is open at the top. The animals pass along this passage way till they arrive at the slaughtering pen. A few seconds later and two by two they fall dead without a groan or struggle.

The door at the other end of the pen is raised, a hooking chain passed round the neck of each carcass, and the dead animal is drawn out upon a broad platform. Then the carcass is hoisted and men fall to work trimming and cleaning it.

All the while these operations are going on, the carcass is moving along, being fastened to a track overhead. The men stand still in their several places, and, as the body is moved along to them, each one performs his part of the work. Nothing is wasted, not even the horns and hoofs.

In about fifteen minutes from the time of his death the animal who passed through all this, has been cut into "hind" and "fore" quarters and carried into a room to cool.

When the meat is thoroughly cold the cars are run up near the cooling-room, and the great quarters of beef are hung from the hooks at the top of the inside of these cars. The car has its side-walls double, and a current of cold air is forced between them from the refrigerator in the front of the car. When the car is

closed it is air-tight and the meat can be carried a long distance and be kept fresh.

A great deal of it is carried to the ships to be taken away to foreign lands. This butchering and meat packing business has, of late years, like all other large enterprises, been concentrated into the hands of a few very large concerns. Their growth is typical of the trend of all modern business. Take, for instance, the evolution of the $400,000,000 yearly business of Swift & Company, of Chicago, from the slaughtering of a single heifer, all he owned, by the late Gustavus F. Swift, then a boy of eighteen, in Barnstable, Mass. It is a matter of only about fifty-five years.

The heifer cost twenty dollars, and young Gustavus made a profit of ten dollars on the transaction. The capital of the Swift enterprise thereafter consisted of this thirty dollars, plus his strength, his keen mind and his indomitable energy.

The boy Gustavus, then eighteen, had been working since his fourteenth year for a Barnstable butcher, earning from one to four dollars a week, so he had some little knowledge of the business. His profits on the wholesale and retail dressed-meat end of the transaction were, as indicated, fifty percent; to-day the scarcity of cattle and the sharp competition in the business have reduced the margin of profit on dressed meat, aside from the scores of by-products of which young Gustavus then had little conception, to about twenty-one cents on each dollar of sales.

The corporation headed by Gustavus F. Swift's sons had at the end of its last fiscal year, in 1913, a capital of $75,000,000. This is something of a rise in values from the original thirty-dollar transaction. More then 10,000,000 head of livestock were bought by the company in 1913, and the single man engaged in the business has grown to an organization of over 35,000 persons. Its packing houses have followed the cattle to Kansas City, Omaha, St. Louis, St. Joseph, St. Paul and Fort Worth, Texas. And as the cattle ranges of this country are fast vanishing, being cut up into homesteads or transformed into grain fields, under the pressure of the demand for more intensive agriculture, the great meat packers have leaped over the last frontier and have established or purchased "frigorificos" in Argentine and Uruguay and packing houses in New Zealand and Australia.

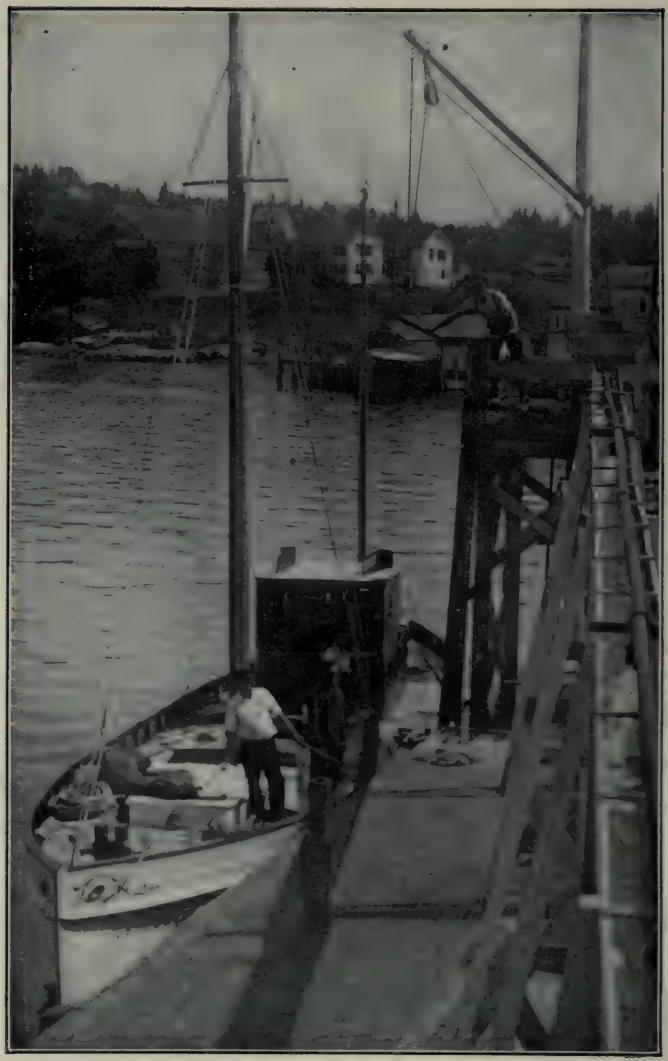
By far the most important concerns in the beef business are the Armour, Swift, Morris, National Packing, Schwarzschild & Sulzberger, and Cudahy Packing companies, which are frequently designated in the trade as "the Big Six."

All of the companies above named slaughter not merely cattle, but also enormous numbers of hogs, sheep, and calves. Most of them do an extensive business in the purchase, storage, and sale of dairy products, eggs, and poultry, while some also engage largely in other related industries. All of the companies have private refrigerator car lines for the

transportation of their packing-house products. All of them maintain a large number of branch houses in cities and towns throughout a large part of the United States, through which they market as wholesalers the greater proportion of their output, particularly of dressed beef.

We Now Consume:
91 per cent of our wheat.
98 per cent of our corn.
In 1906, cattle exported, 525,000 head.
In 1912, cattle exported, 105,000.
Decline, 75 per cent in six years.
In 1906, cattle imported, 16,000 head.
In 1912, cattle imported, 318,000 head.
Increase, 2,000 per cent in six years.
In 1907, number beef cattle, 51,566,000.
In 1913, number beef cattle 36,030,000.
Decline, 30 per cent in six years.

U. S. ten year wheat yields, farm average, 14 bushels.
Farm average, Western Europe, 32 bushels.



UNLOADING FISH

FISH

THERE is one harvest which rewards labor all the year round, without ploughing or sowing. Our fisheries give employment to a number of hardy men and are a rich source of wholesome and varied food for many people.

There are home fisheries and distant fisheries; fishing-grounds that are netted or seined all through the year, and others only at certain seasons. An important fishery is that of Newfoundland, on the Atlantic Coast, off which island the "banks" abound with wide-mouthed cod and haddock. Among the most important are the herring and mackerel fisheries.

These fish are generally caught in nets which hang down in the water like a screen. The line of net at the bottom sinks with plummets of lead, and the line at the top floats with corks.

The fish drive on the net and entangle their gills in the meshes, made large enough to admit their heads, which they cannot draw back if they tried,

A FISHERMAN'S HOME ON THE COAST OF MAINE

because the lids of their gills at once open. They have not even the sense to try, but drive forward, and fix themselves the more firmly in their trap the more they are obstructed.

The cod and haddock all belong to one family, their big, wide-open mouths showing how greedy they are for food. They swim near the sea-bed and swallow small fish at a gulp.

Besides the great cod and haddock fishing station on the Grand Banks of Newfoundland, there are also important fisheries on the rivers and coast of New England and on the Middle Atlantic and Pacific coasts. The Great Lakes also furnish large quantities of fish.

Lobster fishing also gives employment to many men on the Atlantic coast. Lobsters are caught in a trap,

HOME OF A LOBSTER FISHERMAN

called a "pot," made of wooden laths with a net at each end, somewhat like a huge wire rat trap. The illustration shows the style of trap used on the Maine coast. Lobsters are considered a great delicacy by many people, but owing to the great demand for them, are growing more scarce every year.

Curing fish is done in two ways. One, called pickling, consists in packing the fish, with layers of salt,

in barrels, after they have been split open, and part of the backbone and the head removed. When they are to be cured dry, they are unpacked and spread out in the sun. When thoroughly cured they are kept cool and dry till they are shipped.

PREPARING FOR THE OPENING OF THE FISHING SEASON IN THE COLUMBIA RIVER, NEAR ASTORIA, OREGON

The salmon industry is one of the most important of the Northwest, the Columbia River being the great highway for the salmon, king of edible fishes. This river is one of the largest rivers of North America flowing into the Pacific Ocean, and forms part of the boundary between the States of Washington and Oregon.

The average salmon is about three feet long and weighs forty pounds. Three of them will fill about

four dozen one pound cans. Salmon canneries are located all along the Columbia to the Great Falls, a distance of 240 miles, the majority being on the Oregon side. The annual output of both States is over one million cases. Most of the work of canning is done by machinery, and the process is very interesting. The fish are handled about twenty-four times before they are ready for shipment.

Finally the filling machine does its work, and all so carefully and exactly that the cans are filled within a fraction of an ounce of the required weight. A good filler packs about one thousand cases of forty-eight one-pound cans each, in a day.

Pacific Fisherman's (January, 1913, issue) estimate of Pacific coast (including Alaska) canned salmon pack in 1912: Chinooks and king, 346,901 cases; sockeye and Alaska red, 2,099,673 cases; cohoes, silversides, 456,508 cases; pinks and chums, 2,060,280 cases; steelheads, 7,198 cases. Total, 4,960,377 cases.

1 case equals 48 pounds.

CHERRY ORCHARD—WESTERN MICHIGAN
(By courtesy of Western Michigan Development Bureau)

PICKING ORANGES

FRUIT

NOW, let us look at something which Nature made all in her own wonderful, silent laboratory. How quietly she went about it, neither fretting nor disturbing any one, not even the bees which crowded around the blossoms, nor the birds when they snatched a few of those delicious cherries. She fashioned them all at the same time, too; yet all of them are perfect.

A FOUR-YEAR-OLD APPLE-TREE NEAR ELLENSBURG, WASHINGTON

Every one has a story of its own, from the great pineapple which gathered up its delight for you beneath southern suns, to those yellow Bartletts which grew by your own door. You know, of course, that these delicious bits are only the ripened seed-vessels of different plants.

Those cherries, plums and delicate peaches and grapes have hidden their seeds away inside the pulp. The melon there has its seeds scattered through the inside like plums in cake; but the raspberries and strawberries and the pineapple have kept theirs on the outside. Peas and beans are fruits, though not as beautiful, that have hidden themselves away in pods.

To grow fruit from the seed produces spurts or new varieties. The usual course followed is by layers, cuttings, buddings, suckers, and grafting. The common strawberry forms natural layers, their twigs strike fresh root, and by cutting them asunder grow into separate plants.

Cuttings also, from any part of a bush, may be made to strike root. A sucker is an under-ground shoot, which rises at a distance from the parent stem. But the larger fruit-trees are grafted. Grafting is the union of two plants in a growing state, through the medium of the sap, just as when our flesh is gashed open from any cause, the two surfaces unite again under proper bandages. Trees often graft upon each other. If two branches, by their nearness, rub together till wounds are made by

APPLE HARVEST—WESTERN MICHIGAN
(By courtesy of Western Michigan Development Bureau)

the friction, and they bleed, the sap from the two mingles, while wood is formed, and the two branches are welded in one.

As the changes, which the sap undergoes, take place in the leaves, the grafts, however many, produce their own varieties of fruit.

The Department of Agriculture at Washington gives the following suggestions for planting trees:

How to Plant a Tree. The proper season for planting is not everywhere the same. When the planting is done in the spring, the right time is when the frost is out of the ground and before budding begins.

The day to plant is almost as important as the season. Sunny, windy weather is to be avoided. Cool, damp days are the best. Trees cannot be thrust carelessly into a rough soil and then be expected to flourish. They should be planted in properly worked soil, well enriched. If they cannot be planted immediately after they are taken up, the first step is to prevent their roots drying out in the air. This may be done by piling fresh dirt deep about the roots or setting the roots in mud.

In planting they should be placed from two to three inches deeper than they stood originally. Fine soil should always be pressed firmly — not made hard — about the roots, and two inches of dry soil at the top should be left very loose to retain moisture.

And now we will conclude by telling you the story

of one man who appreciated the gifts that nature so freely bestows on all who will avail themselves of her bounty:

Appleseed John. Many years ago, before the great Northwest was settled, and while even a large part of New York and Pennsylvania was still a wilderness, there lived a man who spent a large part of his time in what many people considered a foolish occupation. His name was John Chapman, and, according to tradition, he went through what is now western Pennsylvania, Ohio, and Indiana, before the forests were cut away and planted orchards for the settlers who, he was sure, would come later. Many stories have been told of this remarkable man. Perhaps the best is Rev. Newell Dwight Hillis's "The Quest of John Chapman."

It is said that he spent his winters in the settlements near the Atlantic coast teaching the children and doing odd jobs about the farm. In those days the teachers "boarded around" in the neighborhood. Therefore John Chapman had no board to pay, and he needed little money. But he did not ask for money. He was content to receive his pay in the seeds of apples, peaches, pears, plums, and grapes. This is why he was called "Appleseed John." The farmers and the children saved their seeds for him, and when spring came he filled his boat with seeds and started down the Ohio River. At every suitable landing he took his bag of

seeds on his back and trudged through the forest until he found a good open place, and there he planted his seeds, built a fence of boughs about them, and started out again.

Thus he traveled on and on through many springs and summers, planting his seeds in the unsettled western countries for those who would later come and make their home in the new country. When the first settlers crossed the noumtains and began to clear the forests for homes and farms they found orchards and vineyards awaiting them. Although Appleseed John lived many generations ago, a few trees are still standing which are said to have been planted by him. The story of this man, who in his humble way devoted his life to others, is one that may well be told and retold, for while none of us can repeat the work he did, it may inspire us to make some spot on earth better by planting a few seeds or trees for the enjoyment of the next generation.

Thus we see that by man's intelligence our needs are supplied, and the earth made fitter for the habitation of the human race.

Our skill in weaving, our increase in knowledge, our enterprise in trade, our great works of construction all come from the knowledge of man's weakness and needs.

APPENDIX

SILK MANUFACTURES

Taffeta, from the Persian word *taftah,* is one of the oldest weaves of silk known, the name having been used for different materials since the fourteenth century. The taffeta of to-day is a thin, lustrous silk of plain weave, alike on both sides. It comes in plain colors, and in plaids, cords and stripes, both printed and woven. In weaving, many shot and changeable effects are also obtained.

Bengaline is an imitation of an old silk fabric made in Bengal, India, for many hundreds of years. It is woven with a round-corded effect, similar to poplin. Fabrics known as Bengaline are now woven from all silk, from silk and wool, and from silk and cotton. The latter is called cotton Bengaline, although the cotton is in the weft only.

China Pongee is a name given to plain woven silks made in China. The fabric is soft and lustrous, and is distinguished by the irregular threads, caused by some being heavier than others. The silk used in its manufacture is from the cocoons of a wild silk-worm which feeds on the leaves of scrub oak. The name, pongee, is said to be a corruption of Chinese *pun-ki,* meaning "own loom," or of *pun-chih,*" own weaving" (home-made). A machine-woven pongee is made in the United States, and seems much better

woven than the Chinese hand-loom products. China silk is generally plain in color, but it is sometimes printed with figures in a way similar to calico.

Japanese Habutai is a plain woven silk made in Japan. It has a beautiful natural luster, due to its being woven evenly, with warp and weft of the same size and color. The fabric comes in plain colors, also figured.

India Silk is a plain woven silk, made on the primitive hand-loom of India. The warp and weft are evenly woven, producing a luster similar to that of the China and Japanese silks.

Peau de Soie, from the French "skin of silk," is a heavy, soft finished dress silk. It is woven with close fine ribs running weftwise of the fabric, and is used in plain colors. The better qualities are alike on both sides, while the cheaper grades are finished on one side only.

Moire Silk is a *grosgrain* silk upon which a waved or watered effect has been produced by the use of engraved rollers and high pressure or by doubling the cloth upon itself and rolling it between smooth heated rollers.

Sarsenet is a fine, thin silk material, plain or twilled, used by milliners for hat linings.

To the foregoing list may be added Chiffon, Crepe, Crepe de Chine, and Crepe Meteor; Satin, Foulard, and Poplin; Velvet, Panne, Velour and Plush.

SILK INDUSTRY IN THE UNITED STATES

The silk-manufacturing industry is confined to seventeen States, all of which, with the exception of California, which reported three establishments, are located east of the Mississippi River, while sixteen establishments—located in Maryland, Virginia, North Carolina and Georgia—represent the extent of the industry in the Southern States. New Jersey is the most important State in the industry, ranking first at the censuses of 1909 and 1904 in the value of products, with about one-third (33.2 percent) of the total for the United States, and in value added by manufacture.

For the year 1910, the imports of raw silk into this country reached 21,563,782 pounds, valued at $68,102,732. The imports of manufactured silk were $32,370,115. The value of the raw silks imported into the United States in 1904, when manufactured, would be over $170,000,000 showing that the largest part of the manufactured silk used in the United States was made here, or 84%

There are in the United States, by the census of 1910:

Total number of looms	75,000
Total number of spindles	2,405,527
Value of output finished goods	$171,599,000

It estimated that 3000 looms were added during the year 1910.

Calico is a printed cotton cloth, most of the designs used in printing being made in Paris. The name was derived from Calicut, on the Malabar coast, whence printed goods were first imported. The dyes and colors used in printing calico are of two kinds, those which penetrate through the cloth and show almost as brightly on one side as on the other, and those which are intended to be seen only on one side; great pains must be taken in order to make "fast colors."

The color house at the print-works is an important place and the workers there must have a knowledge of chemistry. There are to be seen mills and stones for grinding; rotating machines for mixing, and caldrons and boilers for heating.

Some of the colors must be thickened with starch, or flour, or gum, to make them more like paint than dye; some, in order to be "fast-colors," must be mixed with mordant, a substitute used for "fixing" colors; some must be thinned with liquid, and some must be acted upon by steam after they have been applied to the cloth.

The pattern for that dainty print in your apron was engraved on a roller or cylinder of brass. The roller was coated with varnish and the pattern scratched in the varnish with a fine point. Nitric acid was spread on, which ate into the metal where the scratches had been made, thus engraving the drawing upon the roller. There were just as many separate cells of dye-stuffs

attached to the rollers as there are different colors in your apron, and just as many rollers as colors. When all were ready the wonderful machinery began to turn, each roller and cell of color acting at its appointed time. So perfect were all the adjustments that *one mile of calico was printed in one hour.*

Percale is another cotton fabric having printed designs. It is very closely and firmly woven with a round thread, and contains more dressing than ordinary cotton cloth. Before being printed, the fabric is bleached. Pure white percale is also used, and handkerchiefs, aprons, etc., are made from a very fine quality.

Percaline is a highly finished and dressed percale. After the cloth is dyed it is sized to stiffen it, and also to increase its gloss. The sizing consists of passing the cloth over a roller and through a bath of starch mixture. Then it is calendered; that is, it is passed through the cylinders of a machine. In order to obtain the highest gloss, the cloth is doubled lengthwise, or the pieces are put together back to back. As it passes through the rolls the cloth is wet by steam, the rolls being well heated and tightly set together.

Percaline is dyed in solid colors.

Gingham was originally introduced, with its present name, from India. It is always woven with a plain weave, from yarn that has been previously dyed.

It is made in a variety of styles of plaids, checks, and stripes, and also in plain colors. Sometimes only two colors are used in both warp and filling, and sometimes as many as eight in the warp and six in the filling. The filling is the same as the weft, which you read about in another chapter. As ginghams are woven in such pretty patterns, and wash so well, they are particularly adapted for children's wear. A famous quality of gingham is the Anderson Scotch gingham.

Zephyr Gingham is the name given to the finest grade of gingham made. It is woven in attractive patterns, with either the plain weave, or a small, all-over dobby effect.

Chambray is a standard cotton fabric, ranking next to the better grades of gingham. It is light in weight, always woven with a plain weave, having but one color in the warp, with a white filling. This produces a solid color effect, the white filling softening the color used in the warp. Chambray is woven from all cotton, all silk, or cotton and silk. When woven from all cotton, a regular gingham finish is given to the chambray.

Denim is a colored twilled cotton material, usually woven with a two up and one down twill. It was originally used for men's overalls but it is now made in good colors, and used for hangings, furniture and floor coverings, etc.

Bedford Cord, as its name implies, is a corded material, the cord or line running lengthwise of the cloth and varying in width from one-twentieth to one quarter of an inch. There is also a Bedford Cord woven from worsted.

Piqué is another cotton fabric woven in corded effects, and it is also woven in figured effects. Its name is from the French word for quilting, the material being originally woven in diamond shaped designs to imitate quilting. To weave piqué both a face warp and a back warp are required, the face warp threads being finer than those of the back warp. In the better grades of the fabric, coarse picks, known as wadding, are used to increase the weight and make the cords more prominent. To produce the figured piqué, the binding of the back warp threads into the face cloth is not done in straight lines, as in plain piqué, but the binding points are introduced so as to form the figures.

Poplin is still another cotton fabric having a corded effect, the cord or rib running width ways of the goods. It is usually woven with a plain weave, the ribbed effect being obtained by using a finer warp thread than that used for the filling.

Rep is also a corded fabric having the rib running across the width of the goods. The name is probably a corruption of rib.

Sateen is a light weight cotton fabric woven with a twill. It has a very glossy surface, resembling silk satin, hence its name. There are two kinds of sateen, the difference being in the weaving; one is a warp sateen, the other a filling sateen. It comes in plain colors, also with designs printed on it.

Galatea Cloth, before dyeing, printing or bleaching, is an ordinary warp sateen. It comes in plain colors, also with printed designs on white and colored grounds. These designs consist of figures, dots and stripes.

Italian Cloth is made from all cotton, cotton and worsted, or cotton and mohair. It is a glossy cloth, woven from the gray undyed yarn, and afterward colored in a variety of colorings.

Khaki, used originally for men's clothing in India, now used extensively for military uniforms, and for clothing for outing purposes, is a twilled cotton fabric, earthy brown in color. From this color it takes its name, *khaki* being Indian for earth or dust colored.

Canvas is a heavy cotton cloth, of plain weave. It is used for making shoes, mail bags, hammocks, covering for boats, etc.

Duck is a cotton fabric of a lighter weight than canvas. It is made of coarse two-ply yarn in a plain weave. It is a water-tight material, having excellent

wearing qualities. As it withstands much rough usage it is well adapted to the manufacture of sails, tents, car curtains, etc. Duck of a lighter weight is used for women's skirts, shirtwaist suits, etc., and for men's white trousers.

Drill or **Drilling** is a strong twilled cotton cloth, usually woven with the two up and one down twill. It is used for linings in the manufacture of clothing and for shoe linings.

Cretonne, so named from a Frenchman of that name, who first made the cloth, is a heavy cotton material. It is usually printed in large designs, and is used for draperies, furniture coverings, and other household decorations.

Long Cloth is a cotton cloth of a better quality than the ordinary cotton cloth, being made from a fine yarn of medium twist. It derives its name from the fact of its being used for infants' long dresses. The closeness of the weave and the soft twist of the yarn gives the long cloth a very white appearance.

Batiste takes its name from its inventor, Baptiste, a weaver of Cambrai, France. It is thin and light, being made from a fine grade of combed cotton yarn. The quality of the fabric varies from a very fine to a rather coarse variety.

Linon is a fine cotton fabric closely resembling linen. This resemblance is due to the fact that it is made from combed, long-stapled yarns.

Muslin is a cotton fabric of oriental origin, the name, it is said, being derived from the town of Mosul in Mesopotamia. It is a sheer fabric, woven plain, without any twisting of the filling with the warp threads. Plain white, black and colored muslins are used, as well as those with printed effects.

Organdie is a very fine muslin, so finished that when washed it does not look as well as before, and loses its crispness entirely. Much of the organdie is used in pure white, and it is also dyed in solid colors, usually in the delicate shades of pink, green, blue, lavender, and yellow. When printed, these shades are generally used for the designs.

Swiss is a thin, plain muslin, taking its name from Switzerland, where the manufacture of the fabric has been established for a long period.

Lawn is made from all cotton yarns, woven with a plain weave, one up and one down. The fabric takes its name from Laon in France, where it was first manufactured. When finished, the lawn feels soft and smooth. It comes in plain white, plain black, and colors; also in printed effects on plain grounds.

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